CHRONOLOGICAL I ARCOLOGICAL

Skyscraper Hong Kong

THE VERTICAL CITY

Diplomarbeit
zur Erlangung des akademischen Grades einer Diplom-Ingeneuer der
Studienrichtung Architetktur

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abstract

The title “CHRONOLOGICAL I ARCOLOGICAL Skyscraper Hong Kong has simplicity hidden in the background. “Chronological” represents a brief overview of the short skyscraper history. “Arcology” is a concept for cities that embraces fusion of architecture and ecology. Until the last decades, tall buildings have been seen as major energy consumers for the city. Planners, architects, and public are slowly accepting the concept of sustainability. Sustainability is considered to represent an emerging trend in tall building design. This thesis paper examines the relations between towers and urbanism, old – new tall building typologies, and new models for sustainable city and urban growth. It provides an analysis of tall building’s structure, program and urban context, as elements of the city fabric. It considers past, present, and future design methods and urban strategies, and gives critical review on some past abandoned utopian ideas (projects).

kurzfassung

Der Titel „Chronologischer Arkologischer Wolkenkratzer Hong Kong“ verbirgt Einfachheit in seinem Hintergrund. „Chronologisch“ bezeichnet einen kurzen Überblick der nicht so langen Geschichte der Wolkenkratzer. „Arkologie“ steht für ein Stadtkonzept, das eine Verschmelzung zwischen Architektur und Ökologie umfasst. Entwerfer, Architekten und die Öffentlichkeit gewöhnen sich langsam an das Konzept der Nachhaltigkeit. Nachhaltigkeit ist die neue Tendenz in der Gebäudeplanung. Diese Diplomarbeit untersucht die Beziehungen zwischen Türmen und Urbanismus, die neuen alten Typologien für Hochhäuser sowie neue Modelle für nachhaltige Städte und Stadterweiterung. Sie setzt sich mit den Hochhausstrukturen, dem Programm und dem städtebaulichen Zusammenhang auseinander, welche gemeinsam die Bestandteile einer Stadt darstellen. Sie berücksichtigt die ehemaligen, die gegenwärtigen und die zukünftigen Entwicklungsmethoden sowie städtebauliche Planung und bietet eine kritische Einsicht in verlassene utopistische Ideen (Projekte).

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sustainability

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project

introduction

introduction

By 2050, it is estimated that eighty percent percent of the world's population will live in urban areas. The world is denser than ever before. Current global urbanization is the largest movement of people in human history and so many different urban processes are currently happening. New cities have been built almost overnight [1][2].Some places have been already abandoned and forgotten. Cities are constantly changing. The number of cities and megacities have continued to rise. Nowadays we have more than 20 so-called megacities (> 10 million populations).

Societies today have many issues to deal with in regards to planning for sustainable future. Architects, engineers and urban planers are constantly searching for the right typologies and urban models to accomplish that goal. The world desperately seeks space and food. Demands for resources are high and in many places entirely exploited.

One of the solutions to this problem, especially in danced cities, is different high-rise typology. We have seen increasing numbers of tall buildings being built in the last few decades across the globe and in all surroundings reaching heights like never imagined before.

[Fig.1] Dubai,UAE 1990s

[Fig.2] Downtown Dubai,UAE 2013

‘tall’?

Since the early beginnings of our civilization, reaching skies has always occupied the human mind. There are many different reasons for this obsession, such as to get closer to God, pure prestige, or putting up a good defence against the enemies. The idea of building tall is not new indeed, but just lately has become possible. With the technological breakthroughs of the 19th century and the necessity of that time, we could say that new typologies have been introduced, and a new building type, the skyscraper has been “born“.

“Tall buildings, high-rises, super-high rises, super-tall buildings and skyscrapers all define buildings that ascend into the sky.” [1]

The most important factors in the early skyscraper development are innovation of the iron frame and Mr. George A. Fuller’s “curtain wall” system [3], which is the outer covering building system where the outside walls are not load bearing. Second very important factor was the invention of a passenger mechanical elevator in 1853 by Elisha Graves Otis, which prevented the fall of the cab if the cable broke.

The early years of the 20th century show rapid development of the high-rise buildings. Early skyscrapers were office and administrative buildings, where the structure and facade allowed large open space making the new buildings look very representative.

With economic growth, the trend of building skyscrapers has rapidly increased in Chicago and New York, where architects, developers and owners wanted to create something different and more recognizable to the society.

In 1903, Frank Lloyd Wright built Larking Building in Buffalo, New York, where the new approach with open office floors, full-height atrium and peripheral service towers was presented, and it became a representative way of planning for the future office high-rise buildings.

1 Krummeck 2010, 4.

[Fig.3] Flatiron Building (Fuller Building), Manhattan 1902

According to Ali and Armstrong, the popularity of high-rise buildings opened the door for adventurous architects and engineers to engage in reinvention of the type and to test new technologies that would enable them to build even higher or to alter social and cultural circumstances. [2]

The later development of skyscrapers was influenced by variety of different reasons. With setback strategy and 1916's Zoning Resolution, the skyscrapers of the 1920s and 1930s have got the new dimension in relation to other buildings, street and pedestrian levels. The 1916's Zoning Resolution is regulation which prevented high-rise bulky mass buildings (e.g. Ernest R. Graham`s Equitable Building 1915) to overshadow streets of Manhattan. Regulation affected the form and volume of the New York skyscrapers for three quarters of the plot, with width of the street and setback angles. The resolution did not impose height limits. New York setback strategy affected new developments of that time in other countries and cities worldwide.

With design of The Downtown Athletic Club in 1931, architects Starret and Van Vleck presented variety of functions in one vertical structure, such as squash and handball courts, poolrooms, locker rooms, oyster bar with a view on Hudson River, Turkish baths, medical rooms, eight-bed station for artificial sunbathing, interior golf course, swimming pool, lounges, library, dance floor, roof garden, bed rooms, utility floor, and etc. Viewed from the outside, it was a classic Art Deco style façade, with large patterns of glass and brick, almost indistinguishable from the conventional skyscrapers surrounding. The form and façade did not reveal inside program of the building. Cities are evolving with time, and architecture of tall buildings is constantly being changed. New prototype of urban design was born in 1940 with Raymond Hood's Rockefeller Centre in New York [4], which is an integrated cluster complex of many tall buildings in the Art Deco style. This was a first high-rise building complex that integrated multi-functional public open space, with flexible conversion of open space function (open air winter skating park), multi-level pedestrian paths, and retail, with shops, cafe and restaurants. The relationship between space, structure and services was changed forever. This type of skyscraper that is integrated with its surroundings has become an inspiration for today's skyscraper developers.

2 Vgl. Ali/Armstrong 2010, 3.

[Fig.4] The view of the GE Building at the heart of Rockefeller Center, Manhattan, New York City (2007)

Al-Kodmany and Ali founded that in order to shape the vision for future cities, the existence of harmony between tall buildings and the city fabric is necessary. The emphasis should be put on technological innovation and creativity of artistry in design while making sure that the social context is not being jeopardized. [3]

The trend and tendency of building mixed-used skyscrapers comes later in the end of the 20th century. Presently, the range of functions of tall buildings has changed from single function program (offices) to residential, commercial, industrial and mix-used functions. Today's skyscrapers are available to public use, and they are no longer the sole asset of people with high social status.

Krummeck explained that the growing trend in ever-dense clusters is development of residential and commercial accommodation, and that this concept has been widely successful in urban development as well as having a major influence in development of Chinese mainland. [4]

According to Hong Kong Department of Statistics in 2008, the population of Hong Kong Island [5] on the area of 20 km2 of developed land was 1.3 million people. Just 25% of Hong Kong Island (80 ha area) is urbanized, where 75% are parks and mountains.

"Global urbanization and migration result in the need for high-density development in cities."[5] Krummeck mentioned that the prime example of this is Hong Kong, a city that is known to be one of the densest cities in the world because of its large population and limited source of land. Furthermore, he stated that because Hong Kong wanted to leave the rural areas untouched, focusing on constructing high-rise apartments and office buildings became the only option to accommodate the vast population's needs. Krummeck noted that research done by the professional website on global building, Emporis, stated that out of 100 tallest residential buildings in the world, 36 are found in Hong Kong. [6] The growth of town population is a major factor to a constant change in height of buildings being built.

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3 Vgl. Al-Kodmany/Ali 2013, 5.
4 Vgl. Luk 2006, zit.n. Krummeck 2010, 7.
5 Vgl. Krummeck 2010, 6.
6 Vgl. Krummeck 2010, 6.

[Fig.5] **Aerial Panorama over Hong Kong Central District,** Hong Kong Island

Tall buildings are reaching heights that have never been reached before, and they are growing in numbers and popularity, both in developed and developing cities across the world.

According to the Council on Tall Buildings and Urban Habitat CTBUH[7], we are entering the era of “Mega tall” with buildings in heights over 600 m! In 2009, the height of 828 m and with more than 160 stories was successfully accomplished with the construction of the Burj Khalifa in Dubai, which was designed by Skidmore, Owings, and Merrill (SOM) Architects Team. The future projects are aiming to even bigger heights, like the Kingdom Tower in Jeddah, Saudi Arabia, with planned height of over 1,000 meters [6].

7 CTBUH - The Council on Tall Buildings and Urban Habitat is a International body in the field of tall buildings and sustainable Urban design, Online under: http://ctbuh.org/

[Fig.6] **Kingdom Tower in Jeddah**, Saudi Arabia (under construction)

When is the building considered to be "tall"?

At the international level, there is not yet universally accepted definition of a "tall building". Definition is relative to the context and it still differs from country to country.

German regulations define tall buildings as buildings higher then 22m, because of fire safety regulations (limitation of ladders used by the fire-fighters). Buildings over 20m(66ft), buildings of any height which is strongly higher than surrounding area, and buildings which make significant impact on the city skyline are defined tall for the Leicester City Council in UK. Regulations in Cork City, Ireland define building of 10 stories or higher as tall. Buildings over 91m (300ft) are defined tall for the ASHRAE[8] Technical Committee for Tall Buildings.[9]

8 ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers is International technical society, Online under: http://www.ashrae.org/
9 Vgl. Al-Kodmany/Ali 2013, 11.

[Fig.7] **World Financial Center Shanghai,** view from Shanghai Tower (2013)

definition of “tall”

definition of "tall"

definition of “tall”

CTBUH resolves definition of ‘tall’ from few perspectives, and sets up the following criteria:

Height Relative to Context

Proportion

Tall Building Technologies

The first criteria defines tall building according to its surrounding.[8][9]It means that “high” in one place may not be considered “high” in another place, e.g. 18-story building in Hong Kong is not considered tall according to its surrounding, but 18-story building is significantly tall for an old city centre of Graz. With this criterion, what was earlier considered to be tall, today may not be, e.g. in Dubai, in the 1990s, a 15-story building was significantly tall, but when compering with the present 163-story Burj Khalifa, this building loses the status of tall building.

The second criteria implies the importance of the building’s proportion and not just height. There are many large-footprint buildings which are quite tall but their size/floor area rules them out of being classified as tall buildings.

The third criteria considers a building being tall, if it contains technologies which may be attributed as being a product of “tall” (e.g., specific vertical transport technologies, structural wind bracing as a product of height, etc.)

According to CTBUH ‘Skyscraper Center’ there are only 73 supertall and 2 megatall buildings completed and occupied globally (July 2013).

definition of “tall building” is relative to conte

[Fig.8] **Hong Kong Island Skyline,** 2011

xt and it still differs from country to country

[Fig.9] **City Centre Graz, Austria** - the view from Schlossberg

After defining tall building under this framework, furthermore CTBUH divides buildings based on their height under few subdivisions:

“Tall”

“Supertall” – buildings over 300 meters (984 feet) in height

“Megatall” – buildings over 600 meters (1,968 feet) in height

The CTBUH recognizes tall building height in three categories:

Height to Architectural Top

Highest Occupied Floor

Height to Tip

“Height to Architectural Top” is measured from the level of the lowest, significant, open-air, pedestrian entrance to the architectural top of the building, including spires, but not including antennae, signage, flag poles or other functional-technical equipment. This measurement is the most widely utilized and is employed to define the Council on Tall Buildings and Urban Habitat rankings of the “World’s Tallest Buildings.”[10]

CTBUH also sets a framework for tall building usage and structure material. According to CTBUH Telecommunications/observation tower needs to have more than 50% usable floor area in order to be defined as tall building. Furthermore, buildings are differentiated by its functions [10]:

1. Single-function tall building - 85% of total floor area occupy single function

2. Mixed-use tall building – two or more functions, where each function occupy more than 15% of total floor area, or total building height

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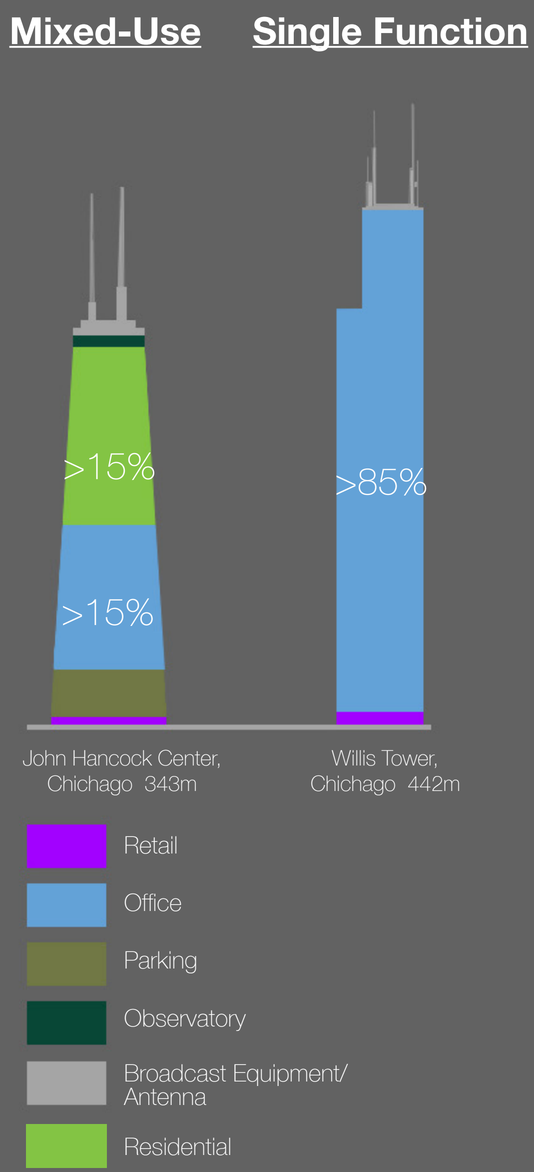
10 CTBUH Height Criteria



[Fig.10] **Single-function and Mixed-use buildings**

Classification based on structural material considers construction material of the main vertical and lateral structural elements and floor systems in one tall building. CTBUH recognizes:

Steel Tall Building

Concrete Tall Building

Composite Tall Building

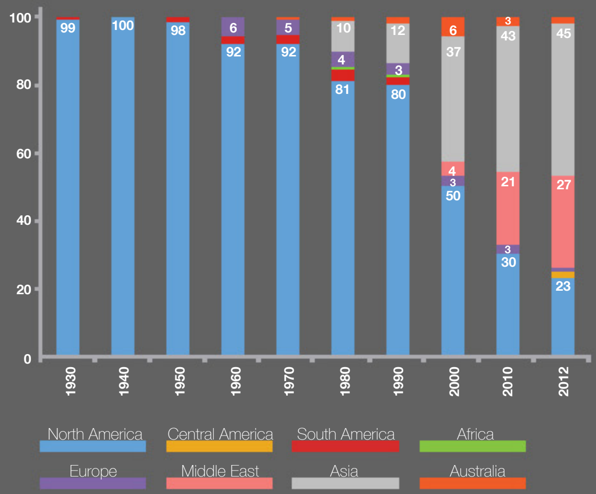
Mixed-structure Tall Building

Composite Tall Building is combination of both steel and concrete acting compositely in the main structural elements, thus including a steel building with a concrete core.

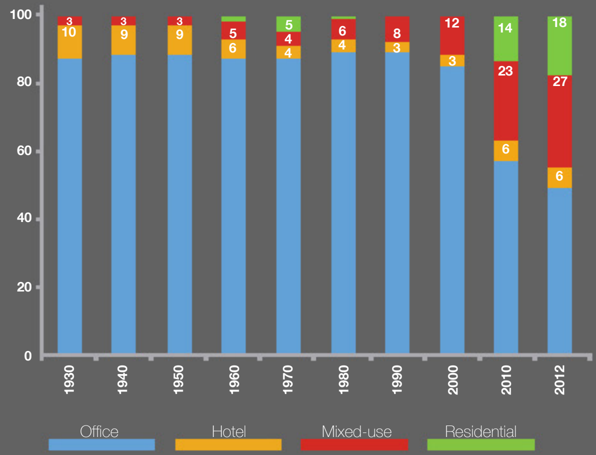
Mixed-structure Tall Building is building that utilizes distinct steel or concrete systems above or below each other.[11]

For the most complete definition of tall buildings and building height, this paper will use CTBUH criterion.

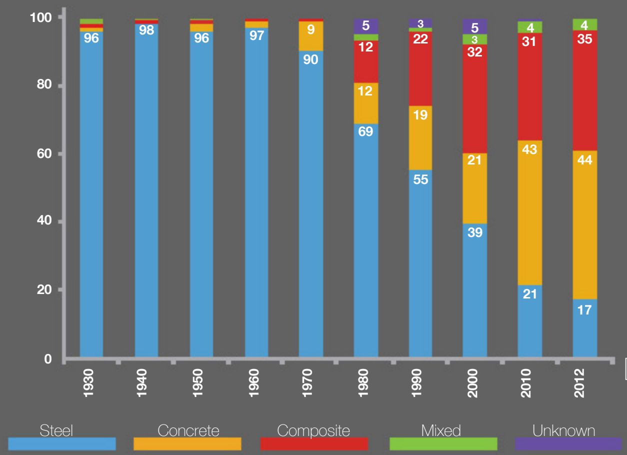
11 Vgl. CTBUH Height Criteria



[Fig.11] **100 tallest buildings by location**



[Fig.12] **100 tallest buildings by function**



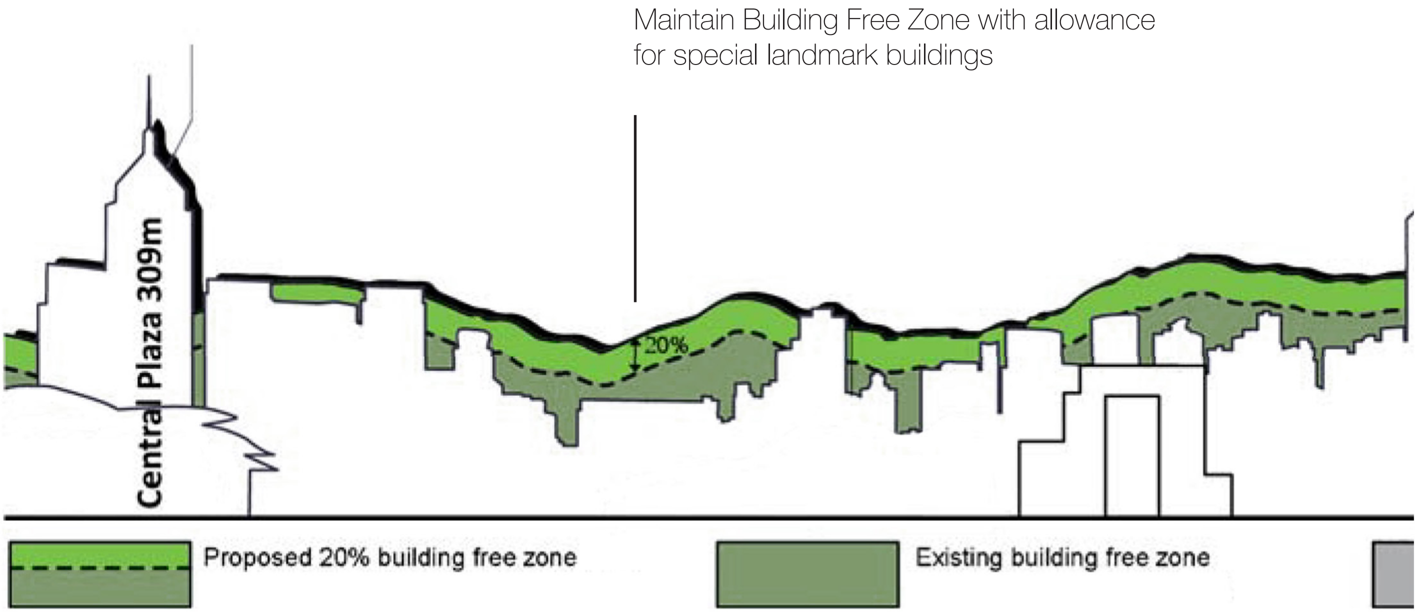
[Fig.13] **100 tallest buildings by structural material**

In some Asian countries and cities, there are height regulations and preservations e.g. Singapore, Indonesia, Hong Kong, mostly because of the strict fire and security codecs or heritage protection, airflow and shadowing effect. In Europe, there is no official law for height regulation, except some cities that preserve view on heritage buildings and old city centers (e.g. Athens, Graz).

Al-Kodmany and Ali pointed out that if high-density problem does not exist, the justification for constructing tall building fails.[12]

With the new generation of high-rise buildings the problem of high-energy usage is being considered. The principal criteria of new tall building developments are energy preservation and sustainability. The criterion has a positive environmental impact on the city and it it received the approval.

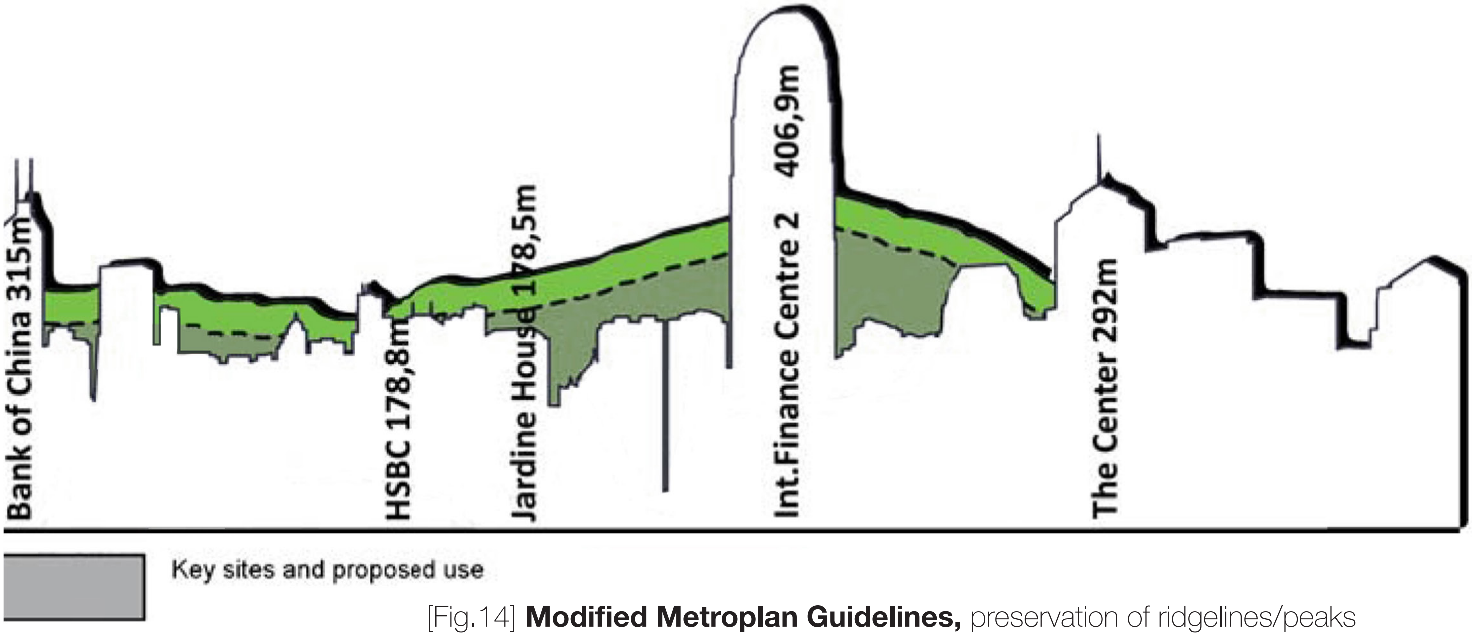
12 Vgl. Al-Kodmany/Ali 2013, 2.



From Al-Kodmany's and Ali's point of view, tall buildings have managed to solve the problem of growing populations and activities on a limited land, however, they did bring concerns such as congestion, overcrowding, and limited access to light and air. In addition, authors warned that planners and designers need to acknowledge the necessity of addressing the wide range of issues including environmental impacts, security, building safety, energy efficiency, access, cost and comfort, amongst the others, when incorporating tall buildings in the cities. To them, a clear vision for future cities is achieving the harmony between tall building and the city fabric. [13]

Abel claimed that eventually the architects will dismissed the flawed urban visions from the past, and target new technologies and new issues, but, he thinks that the focal point for architects and designers should shift from the already mastered "how" of production in the digital age to "what," in order to re-design the modern city that could cope with the difficult challenges of this century.[14]

13 Vgl. Al-Kodmany/Ali 2013, 2.
14 Vgl. Abel 2010, 1.

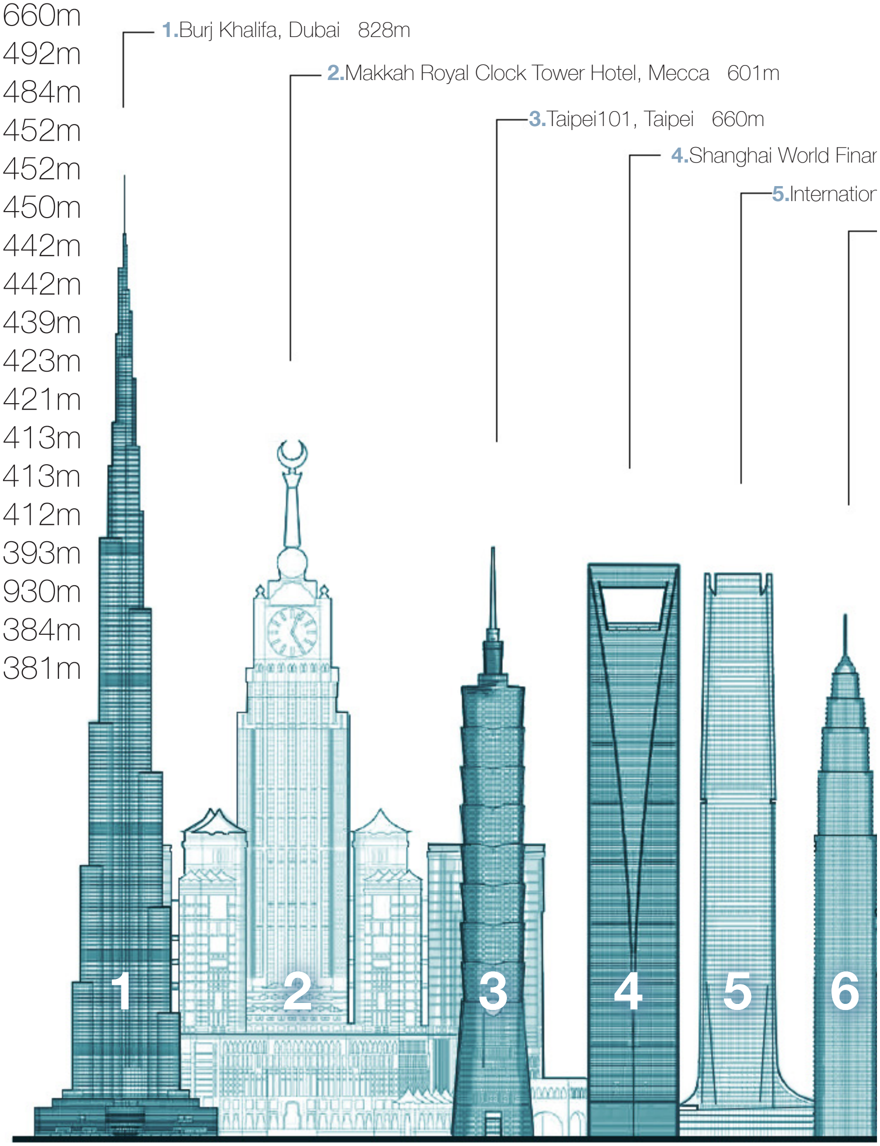


[Fig.14] **Modified Metroplan Guidelines,** preservation of ridgelines/peaks

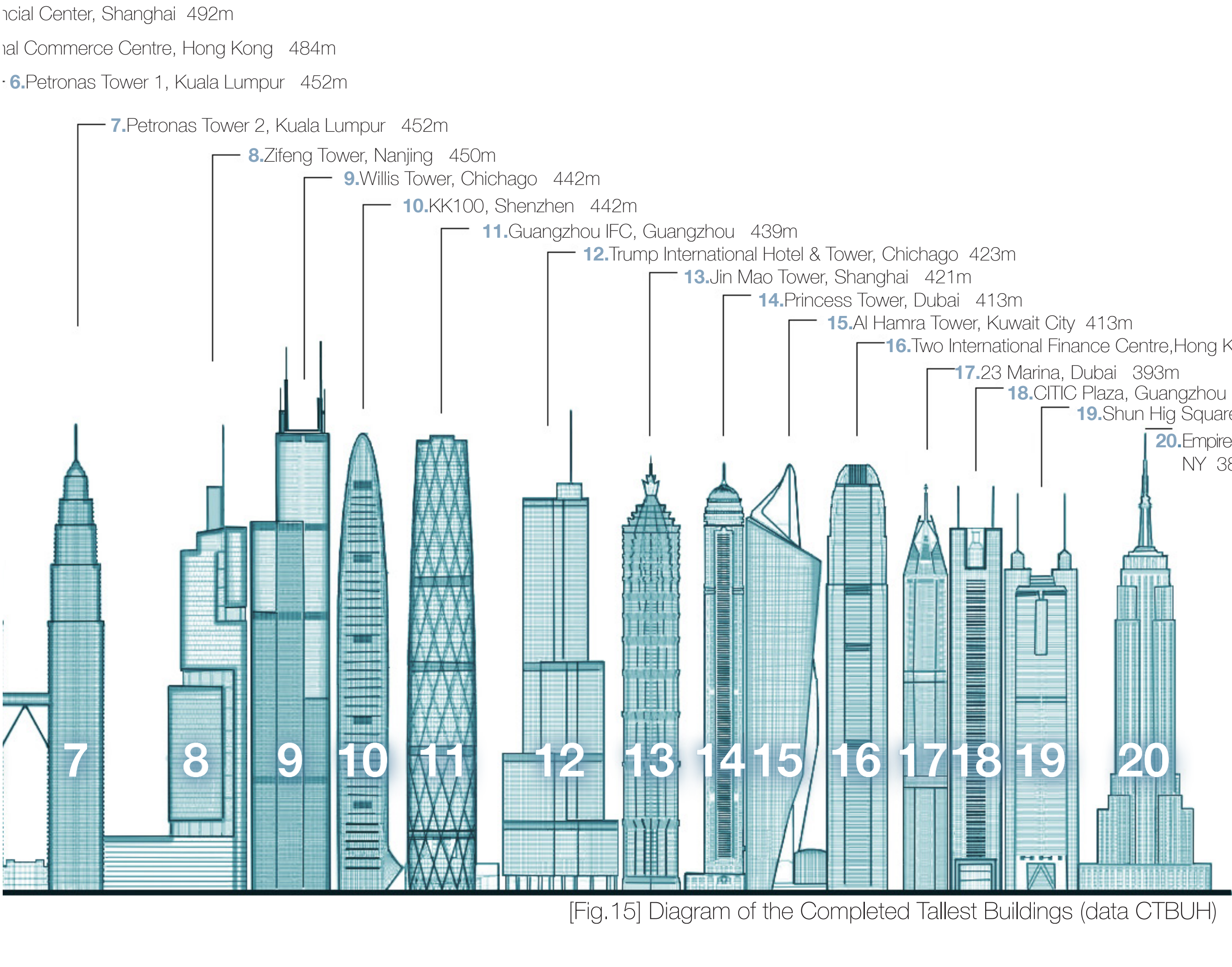
numbers and trends

numbers and trends

1.Burj Khalifa, Dubai	828m
2.Makkah Royal Clock Tower Hotel	601m
3.Taipei101	660m
4.Shanghai World Financial Center	492m
5.International Commerce Centre	484m
6.Petronas Tower 1	452m
7.Petronas Tower 2	452m
8.Zifeng Tower	450m
9.Willis Tower	442m
10.KK100	442m
11.Guangzhou IFC	439m
12.Trump International Hotel&Tower	423m
13.Jin Mao Tower	421m
14.Princess Tower	413m
15.Al Hamra Tower	413m
16.Two International Finance Centre	412m
17.23 Marina	393m
18.CITIC Plaza	930m
19.Shun Hing Square	384m
20.Empire State Building	381m



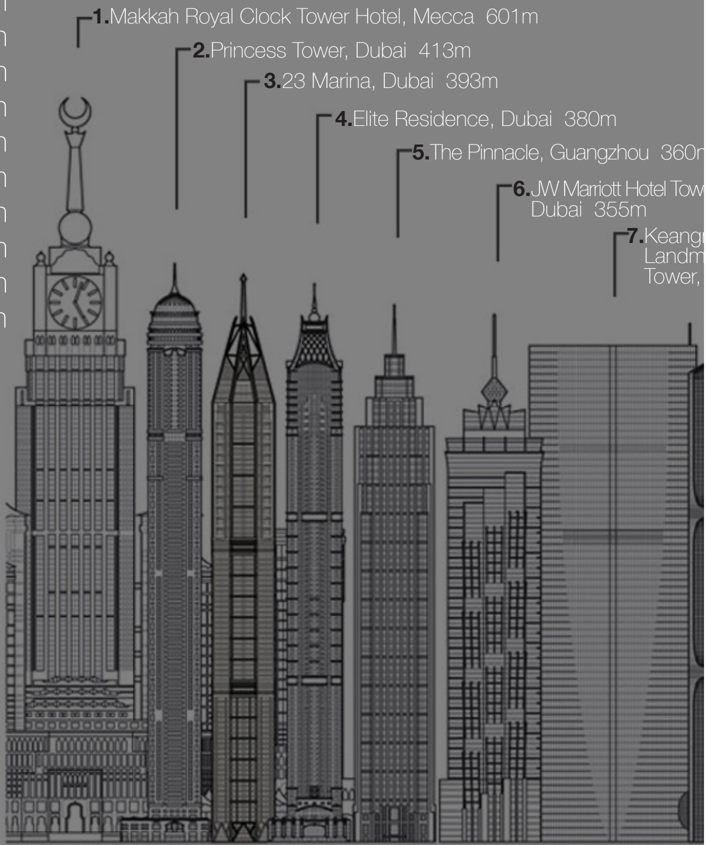
COMPLETED TALLEST BUILDINGS



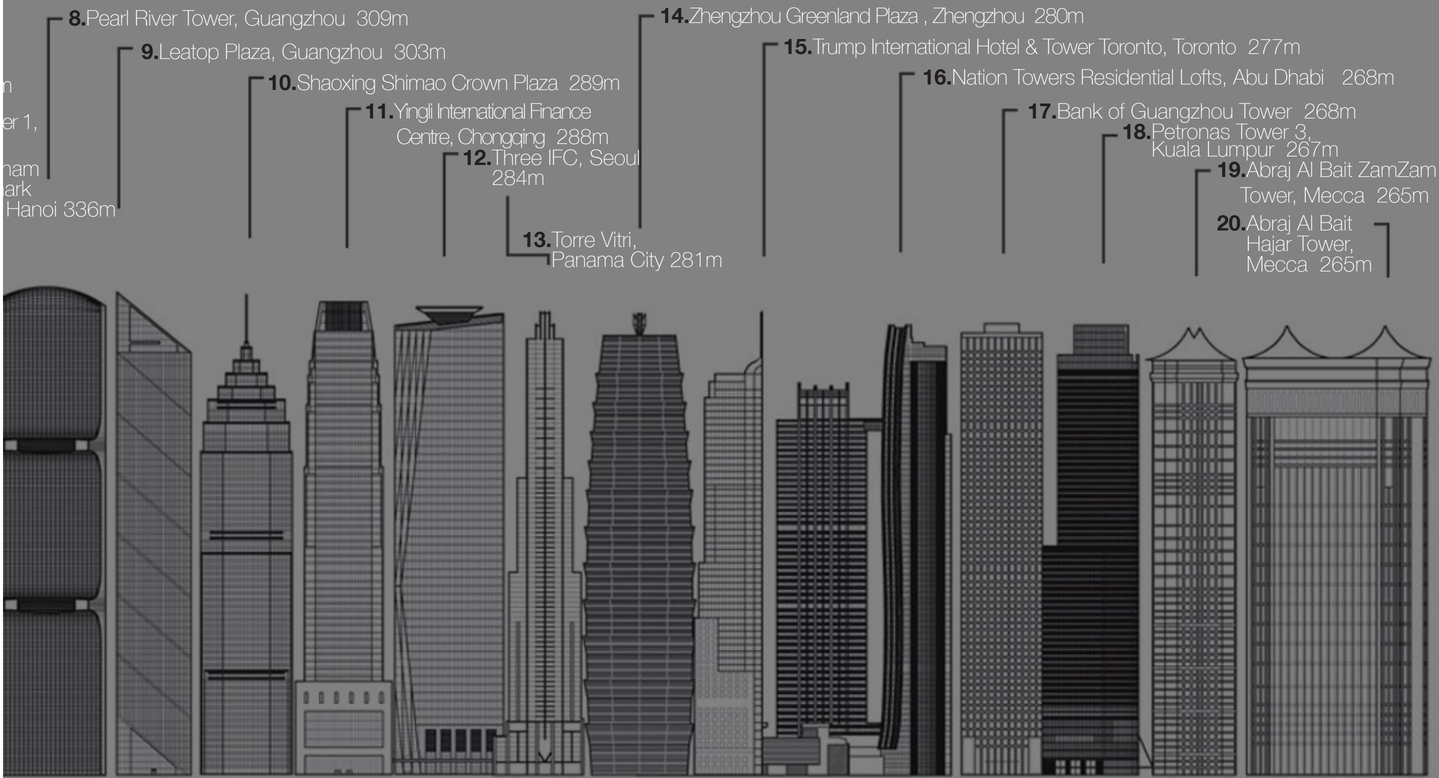
[Fig.15] Diagram of the Completed Tallest Buildings (data CTBUH)

numbers and trends

1.Makkah Royal Clock Tower Hotel, Mecca	601m
2.Princess Tower, Dubai	413m
3.23 Marina, Dubai	393m
4.Elite Residence, Dubai	380m
5.The Pinnacle, Guangzhou	360m
6.JW Marriott Hotel Tower 1,Dubai	355m
7.Keangnam Landmark Tower, Hanoi	336m
8.Pearl River Tower, Guangzhou	309m
9.Leatop Plaza, Guangzhou	303m
10. Shaoxing Shimao Crown Plaza	289m
11. Yingli International Finance Centre, Chongqing	288m
12. Three International Finance Center, Seoul	284m
13. Torre Vitri, Panama City	281m
14. Zhengzhou Greenland Plaza , Zhengzhou	280m
15. Trump International Hotel & Tower Toronto	277m
16. Nation Towers Residential Lofts, Abu Dhabi	268m
17. Bank of Guangzhou Tower,Guangzhou	268m
18. Petronas Tower 3, Kuala Lumpur	267m
19. Abraj Al Bait ZamZam Tower, Mecca	265m
20. Abraj Al Bait Hajar Tower, Mecca	265m



TALLEST BUILDINGS IN 2012



[Fig.16] Diagram of the World's Tallest in 2012 (CTBUH Jan. 2013)

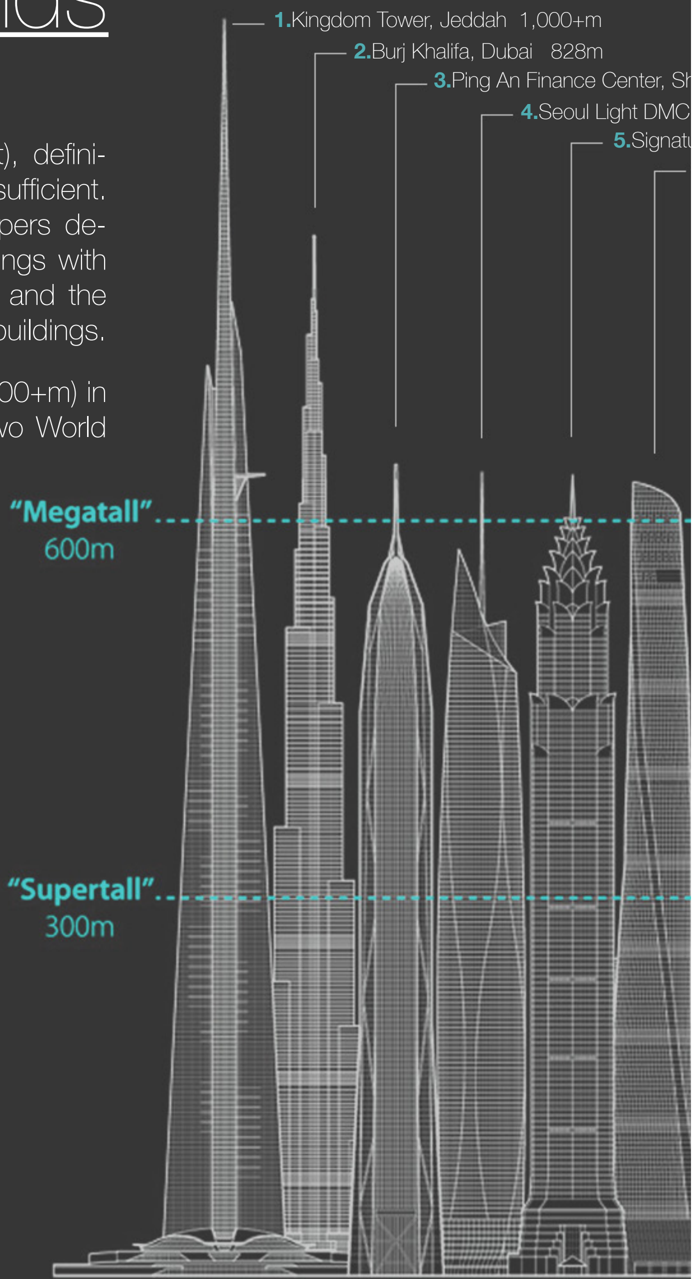
numbers and trends

WORLD'S 20 TALLEST IN 2020

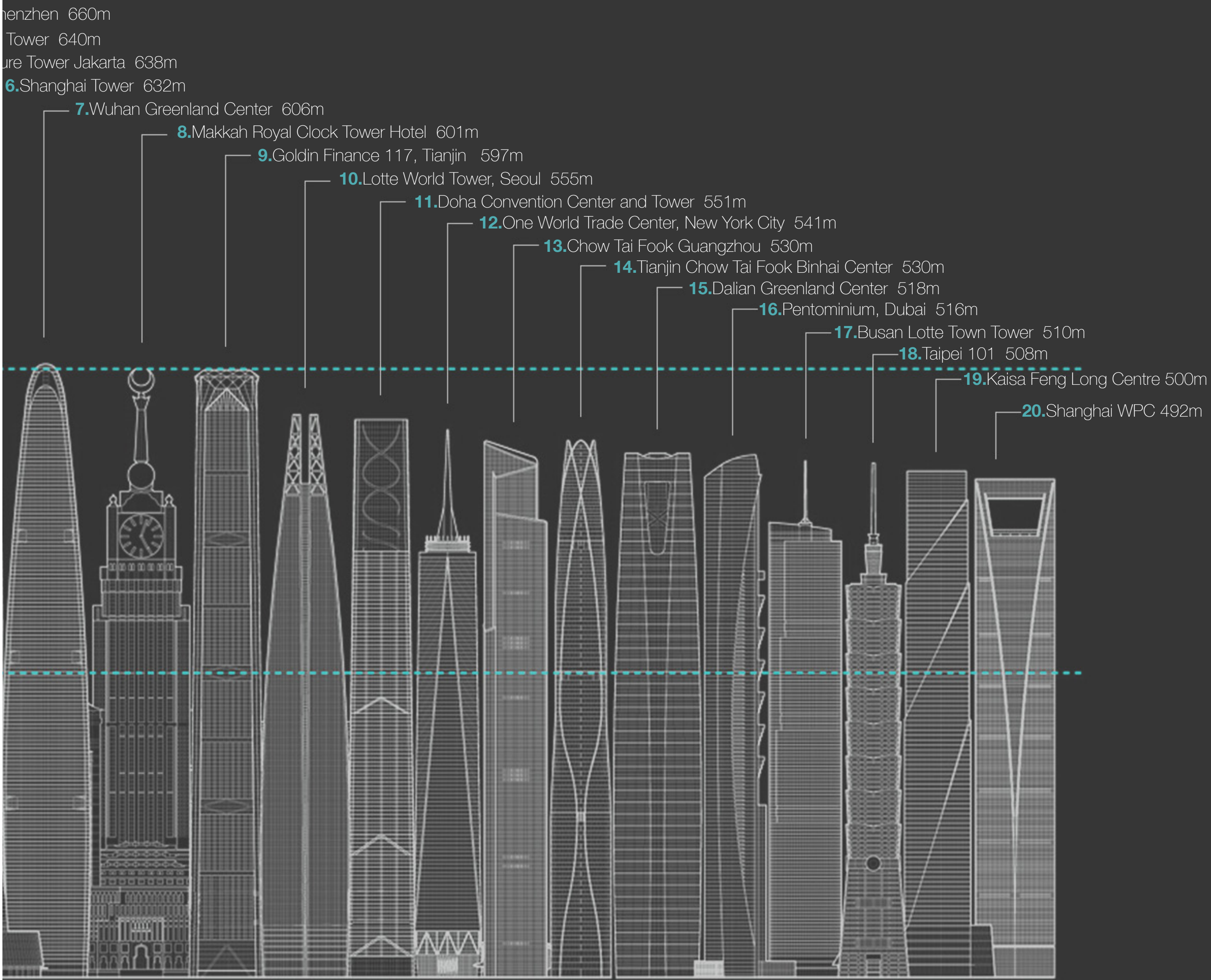
Within completion of the Burj Khalifa (872m/ 2,717ft), definition of 'supertall' buildings (over 300m) became insufficient. Considering this outstanding achievement in skyscrapers design, and in order to assign a new definition to buildings with over 600 m in height, the new term was introduced and the world had entered the era of so called 'megatall' buildings.

Historicaly there have been 74 completed supertalls (300+m) in the world, including the now-demolished One and Two World Trade Center in New York.

1.Kingdom Tower, Jeddah	+1,000m
2.Burj Khalifa, Dubai	828m
3.Ping An Finance Center, Shenzhen	660m
4.Seoul Light DMC Tower	640m
5.Signature Tower Jakarta	638m
6.Shanghai Tower	632m
7.Wuhan Greenland Center	606m
8.Makkah Royal Clock Tower Hotel	601m
9.Goldin Finance 117, Tianjin	597m
10. Lotte World Tower, Seoul	555m
11. Doha Convention Center and Tower	551m
12. One World Trade Center, New York City	541m
13. Chow Tai Fook Guangzhou	530m
14. Tianjin Chow Tai Fook Binhai Center	530m
15. Dalian Greenland Center	518m
16. Pentominium, Dubai	516m
17. Busan Lotte Town Tower	510m
18. Taipei 101	508m
19. Kaisa Feng Long Centre	500m
20. Shanghai WPC	492m



WORLD'S 20 TALLEST IN 2020

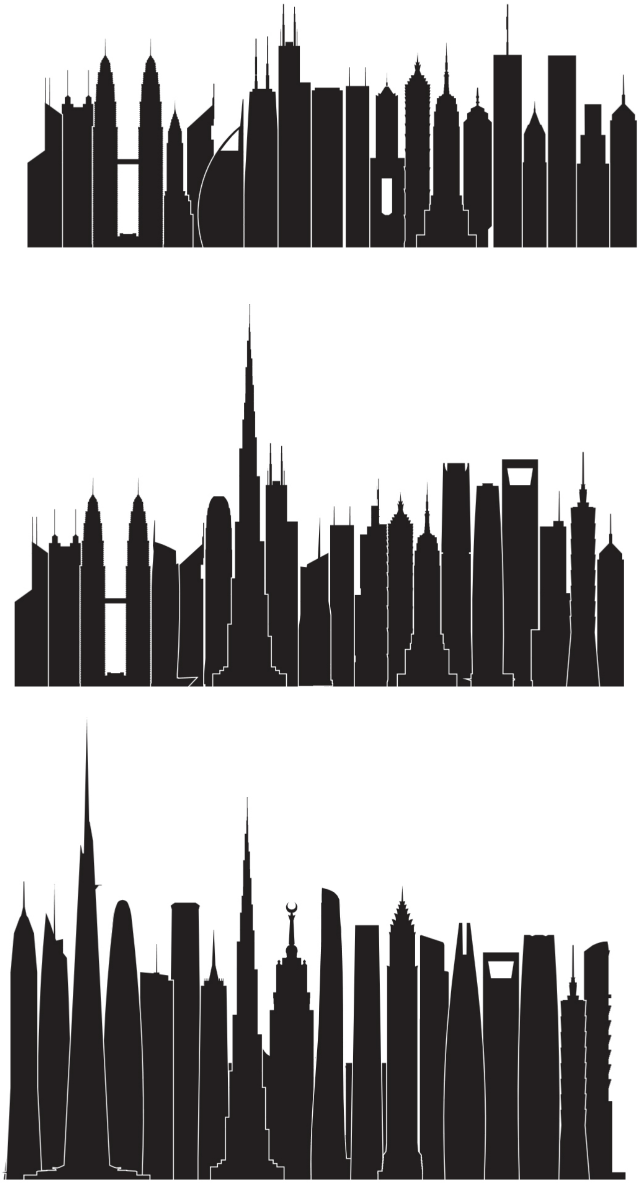


[Fig.17] Diagram of the World's Tallest in 2020 (data CTBUH Dec 2011)

2000
Average: 375 m (1,230 ft)

2010
Average: 439 m (1,440 ft)

2020
Average: 598 m (1,962 ft)



[Fig.18] **Average heights,** from 2000 to 2020 (data CTBUH Dec 2011)

By 2020, at least eight 'megatall' buildings will be built worldwide. The chart 'Tallest in 2020' envisions that the average height of buildings will measure 598 m/1,962ft.

These projects are going to be built across fifteen cities in seven different countries.

Half of the listed projects are planned for China (10 out of 20 projects), followed by Korea (3), Saudi Arabia (2) and UAE (2). Expressed differently, Asia accounts for 70% of the buildings being built (14) and the Middle East accounts for 25% (5).

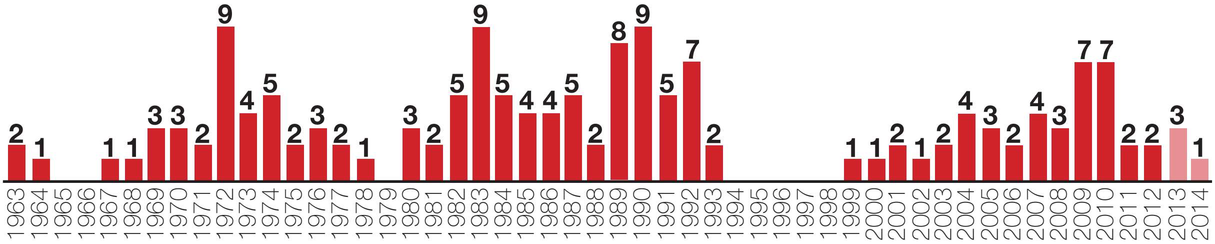
If the Middle East was counted as being a part of the Asian Continent, then 19 out of 20 projects will be located in the eastern hemisphere. The New York's One World Trade Center will be the only project located in the western hemisphere. [15]

At the beginning of the 21st century, the Petronas Towers in Kuala Lumpur with the height of 452m/1,483ft was recognized as the "World's Tallest Building". In 2004, with 508m/1,667ft in height, Taipei 101 overtook the title of the "World's Tallest Building", but within six years, the Burj Khalifa in Dubai with the height of 872m/2,717ft set the new height limits. It will not last for long, because in January 2012, the new project of Kingdom Tower in Jeddah, Saudi Arabia, is expected to be taller than 1,000m. Undoubtedly, the world is entering the era of 'megatall' buildings (over 600m). The trend is expected to continue in the future.

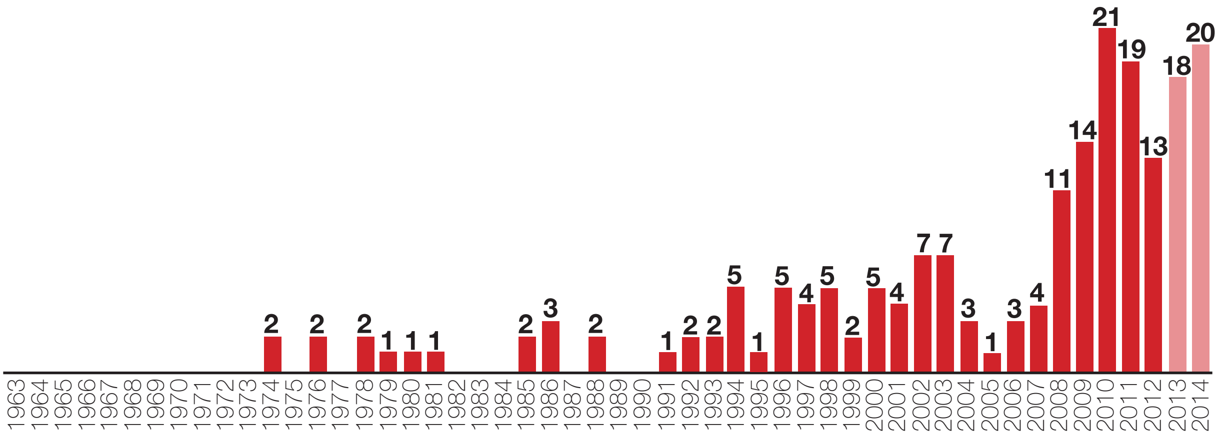
The most amazing fact is that within two decades, the Petronas Towers, went from being the 1st to the 27th tallest building in the world. The CTBUH report on "The Tallest 20 in 2020: Entering the Era of the Megatall" acknowledged the fact that 19 out of the 20 highest buildings in the World by 2020 will be located in the eastern hemisphere. For instance, in New York, in the 20th century, 10 out of 16 "World's Tallest" skyscrapers were built, while today, the power and investments are shifting from the West to the East. Asia and the Middle East, especially China, Korea and UAE, are now the new playground for architects and urban planners.

15 Vgl. CTBUH: 2011, 3.

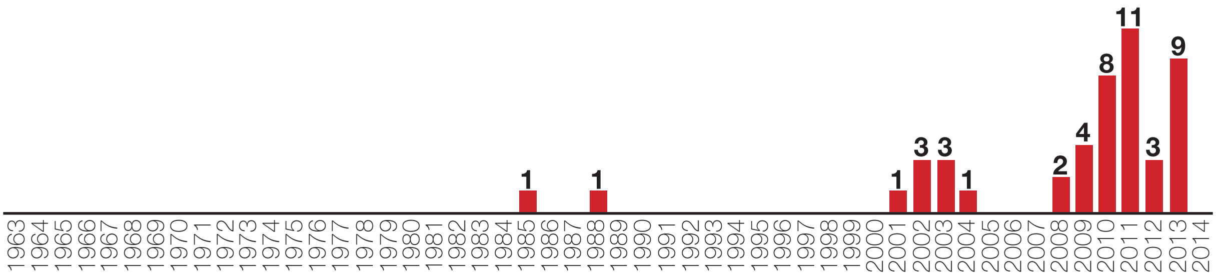
numbers and trends



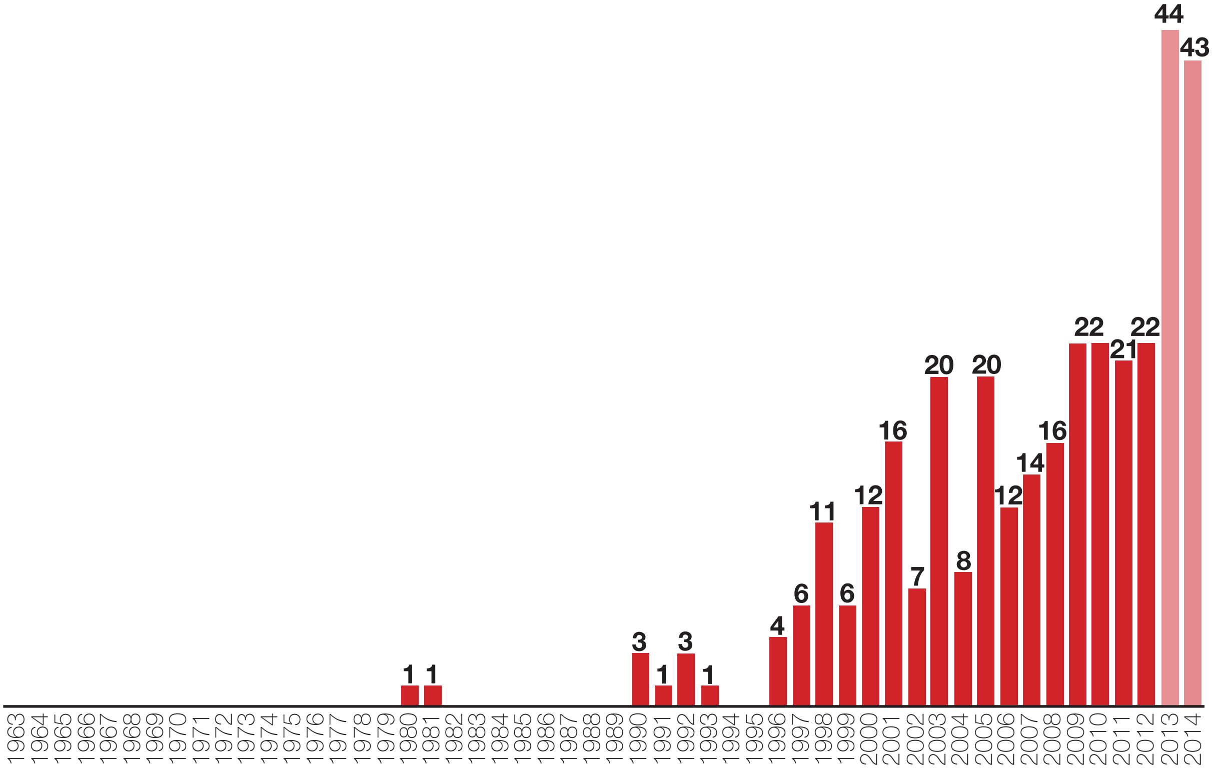
[Fig.19] 200m+Buildings Completed Annually: **USA**. Current Total:164 (CTBUH)



[Fig.20] 200m+Buildings Completed Annually: **ASIA** (not including China). Current Total:153 (CTBUH)



[Fig.21] 200m+Buildings Completed Annually: **SOUTH KOREA**. Current Total: 47 (CTBUH)

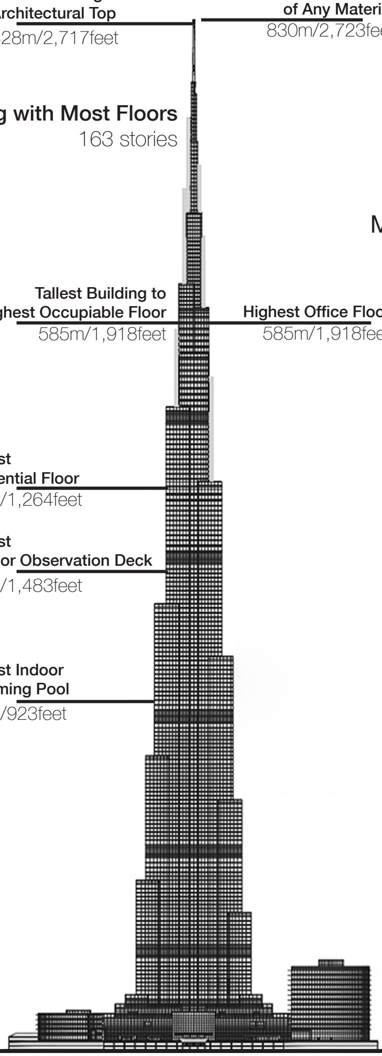


[Fig.22] 200m+Buildings Completed Annually: **CHINA**. Current Total:249 (CTBUH)

numbers and trends

TALLEST WORLD'S RECORDS

[Fig.23] (data CTBUH Sep 2010)



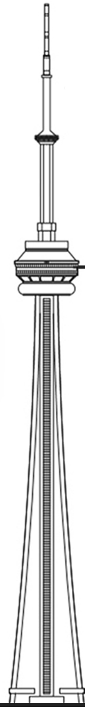
+ 828m 2,717ft

Burj Khalifa,1976
Dubai, UAE
Mixed-use: Office/Residential/Hotel

+ 34 years

CN Tower,1976
Toronto, Canada
Telecommunications/ Observation Tower

is the number of years CN Tower held the title of the tallest free-standing structure on land at 553m/1,815feet, until Burj Khalifa surpassed it in 2010



The highest tip of a skyscraper above sea level is thought to be 3,743 m/12,280 ft, at the top of the Banco Central de Bolivia building, La Paz (which is 107 m/351 ft tall).

At 330 m/1,082 ft tall and 105 stories, the Ryugyong Hotel, Pyongyang, N. Korea holds the record for the longest topped out but not completed skyscraper, standing unfinished for 16 years.

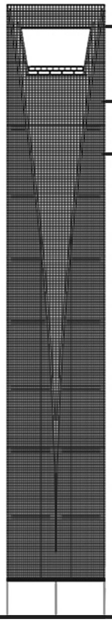
Despite being the world's tallest building, the Burj Khalifa's Observation Deck is not the world's highest, falling 22 m/72 ft short of that in the Shanghai World Financial Center.

+ 41 years

The Empire State Building holds the record for being the world's tallest building the longest; an impressive 41 years from 1931 to 1972. Since the completion of the Home Insurance Building in 1885, 16 buildings have enjoyed the title of the "World's Tallest Building". 12 in the US, with 10 in New York, 2 in Malaysia, 1 in Taiwan, and 1 in Dubai. The average length of time for holding the title is 9 years.

+ 16.8 m/s

the speed of the **Taipei 101** observatory lifts ascending, which make them the world's fastest elevators, with travel distance of 382m/1,253 feet



Highest Observation Deck
474m/1,555feet

Highest Restaurant
414m/1,358feet

Highest Hotel Floor
372/1,219feet

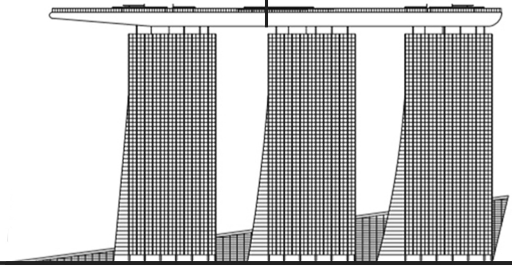
+ 429m 1,614ft

Shanghai World Financial Center, 2008
Shanghai,China
Mixed-use:Hotel/Office

+ 56th

Marina Bay Sands Hotel, 2010
Singapore
Hotel

Highest Skybridge
Highest Outdoor Swimming Pool
189m/618 feet



The tallest wood framed building is the 12-story Reid House, Sydney at 45 meters/148 feet tall.

Although the Shanghai World Financial Center hold the record for the world's highest restaurant, the highest revolving restaurant record is still held by CN Tower since 1976.

With over 350 km of combined height of buildings over 100 m, Hong Kong is the tallest urban agglomeration in the world, 3 times taller than the next tallest city, New York.

[Fig.24] World's Tallest Buildings/Structures According to Function (Sep 2010 CTBUH)

Function	Building Name	Location	Year	Stories	Height (m)	Height (ft)
All-Office	Taipei 101	Taipei, Taiwan	2004	101	508	1.667
All-Residential	Q1	Gold Coast, Australia	2005	78	323	1.058
All-Hotel	Rose Raynahan by Rotana	Dubai, UAE	2007	72	333	1.093
All-Educational	MV Lomonosov State University	Moscow, Russia	1953	39	239	784
Telecommunications/ Observation	Guangzhou TV Tower	Guangzhou, China	2010	-	600	1.969
Hospital	Hong Kong Sanitorium & Hospital Li Shu Pui Block	Hong Kong, China	2009	2009	148	486
All-Student Housing	Nido Spitalfields	London, UK	2010	2010	112	367
Mixed-use: office-/residential/hotel	Burj Khalifa	Dubai, UAE	2010	2010	828	2.717
Mixed-use: hotel/office	Shanghai World Financial Center	Shanghai, China	2008	2008	492	1.614
Mixed-use: office/hotel	New Century Plaza East Tower	Shenzhen, China	2003	2003	177	581
Mixed-use: residential/hotel	Trump International Hotel & Tower	Chicago, USA	2009	2009	423	1.389
Mixed-use: hotel/residential	Conrad International Hotel	Hong Kong, China	1990	1990	199	657
Mixed-use: residential/office	John Hancock Center	Chicago, USA	1969	1969	344	1.128

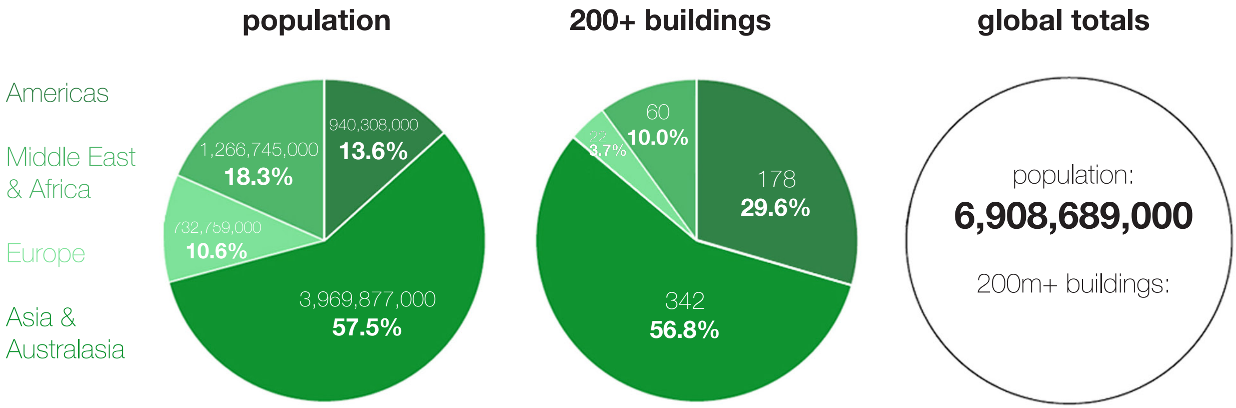
[Fig.25] World's Highest Spaces According to Function (data Sep 2010 CTBUH)

Function	Building Name	Location	Year	Stories	Height (m)	Height (ft)
Office	Burj Khalifa	Dubai, UAE	2010	154	585	1,918
Residential	Burj Khalifa	Dubai, UAE	2010	108	385	1,264
Hotel	Shanghai World Financial Center	Shanghai, China	2008	86	372	1,219
Educational	Mode Gakuen Cocoon Tower	Tokyo, Japan	2008	49	178	583
Observation Deck	Shanghai World Financial Center	Shanghai, China	2008	100	474	1,555
Hospital	Hong Kong Sanitorium & Hospital Li Shu Pui Block	Hong Kong, China	2009	37	140	459
Restaurant	Shanghai World Financial Center	Shanghai, China	2008	93	414	1,358

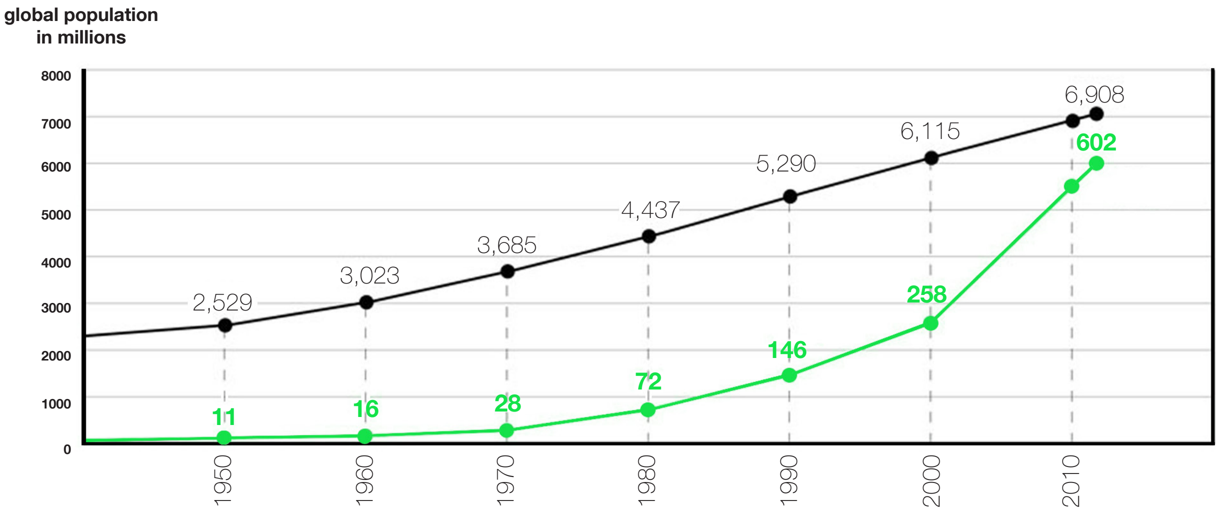
[Fig.26] World's Tallest Buildings According to Structural Material (data Sep 2010 CTBUH)

Function	Building Name	Location	Year	Stories	Height (m)	Height (ft)
All-Steel	Willis Tower	Chicago, USA	1974	108	442	1,451
All-Reinforced Concrete	Trump International Hotel & Tower	Chicago, USA	2009	96	415	1,362
Masonry	Monadock Building (North Wing)	Chicago, USA	1893	16	60	197
Composite	Taipei 101	Taipei, Taiwan	2004	101	508	1,667
Wood Frame	Reid House	Sydney, Australia	1914	12	45	148
Steel/Concrete	Burj Khalifa	Dubai, UAE	2010	163	828	2,717
Concrete/Steel	900 North Michigan Avenue	Chicago, US	1989	66	265	869

numbers and trends



[Fig.27] Regional Population & tall building figures (data March 2011 CTBUH)

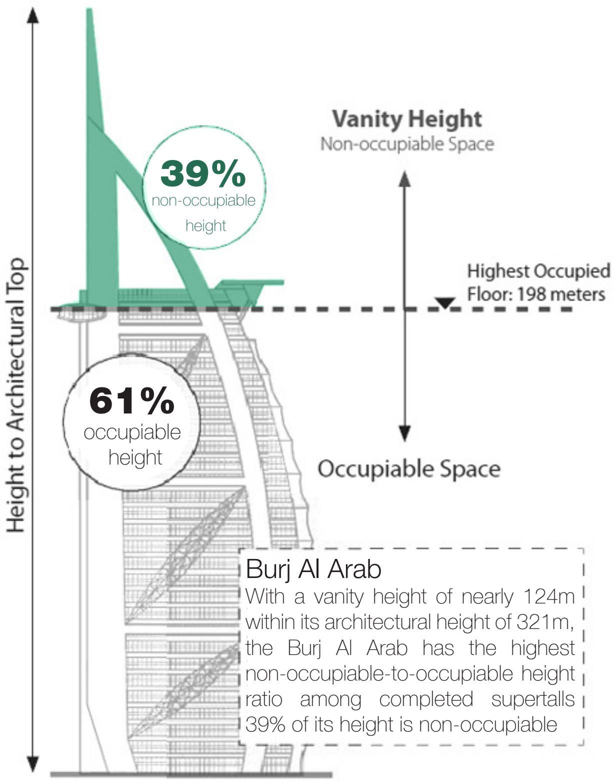


[Fig.28] Global Population & tall building increase (data March 2011 CTBUH)

numbers and trends

Vanity Heights : The Empty Space in World's Tallest

In the case study on Kingdom Tower, Jeddah, issued in the "CTBUH Journal 2013 Issue", authors noticed that certain amount of the building top is not occupied. In further research, CTBUH explored term of 'vanity height' in Supertall buildings. According to CTBUH, authors examined the distance between skyscraper's highest occupiable floor and its architectural top.



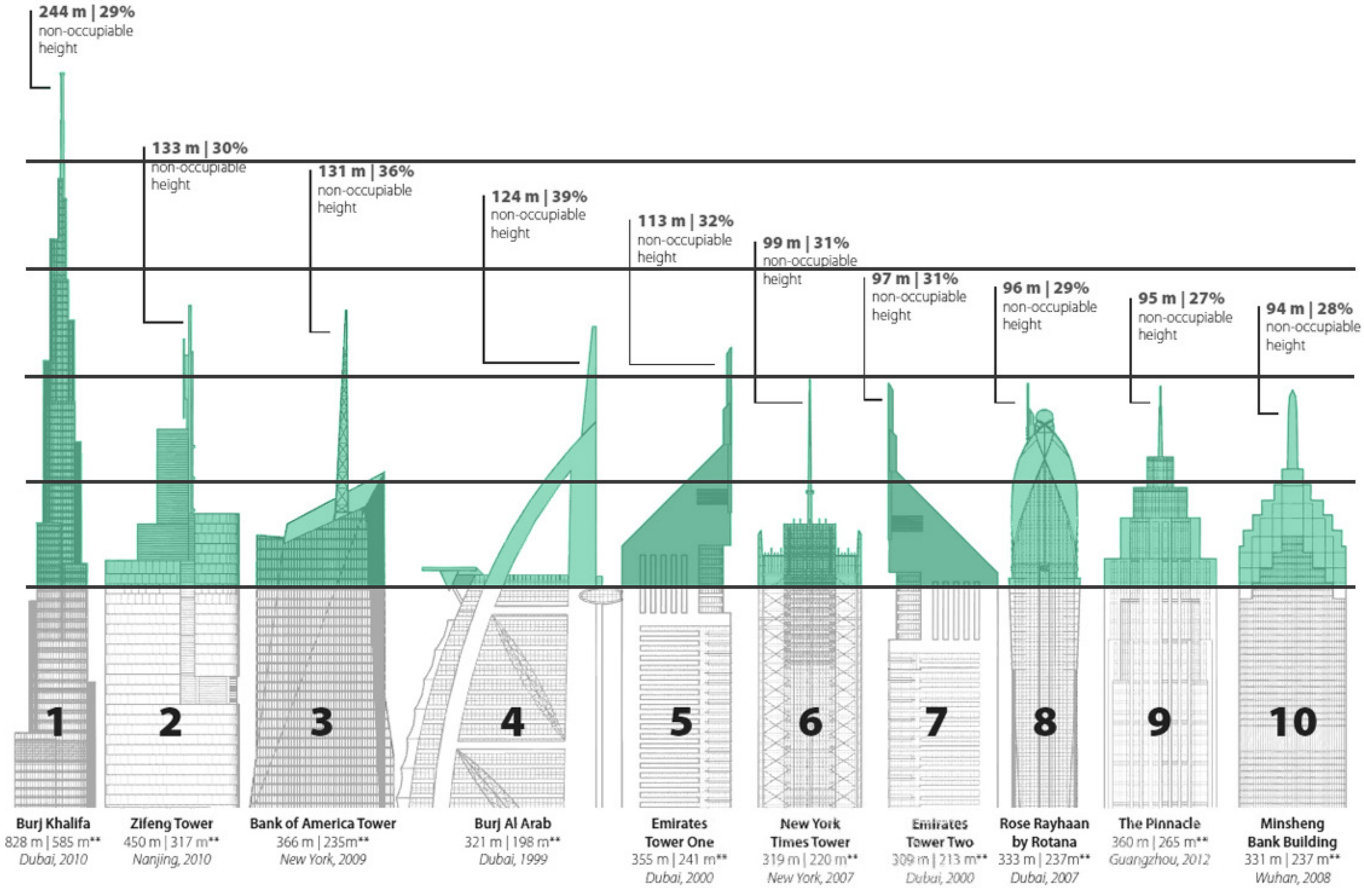
[Fig.29] **Criteria for Vanity Height**
The graph examine the distance between a skyscraper's highest occupiable floor and its architectural top.

Without Vanity Height, 44 (61%) of the world's 72 supertalls[1] would measure less than 300 meters, losing their supertall status. The tallest of these is Guangzhou's 390-meter CITIC Plaza.

According to current CTBUH Height Criteria regarding telecommunications towers, a 50% vanity height would deem any structure a non-building!

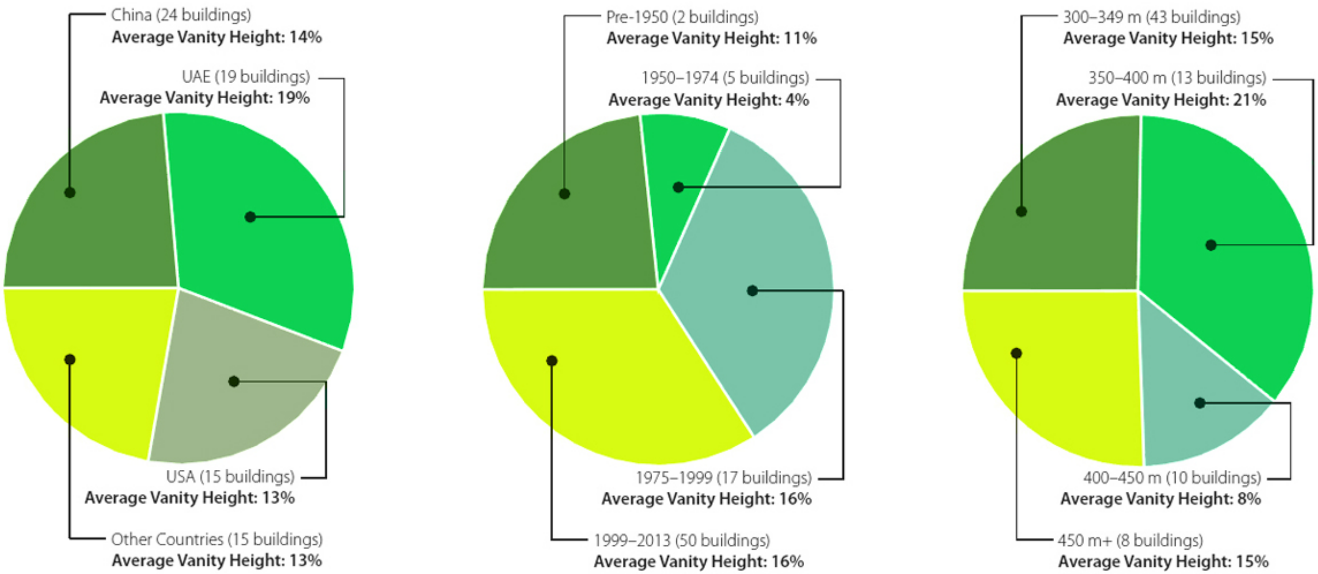
At 244 meters, the Burj Khalifa's Vanity Height would be an impressive stand-alone skyscraper. If built in Europe, it would become the continent's 11th-tallest building.

'VANITY HEIGHTS'



[Fig.30] **World's Ten Tallest Vanity Heights** (data July 2013 CTBUH)
Below are the ten tallest "Vanity Heights" in today's completed suppertalls.

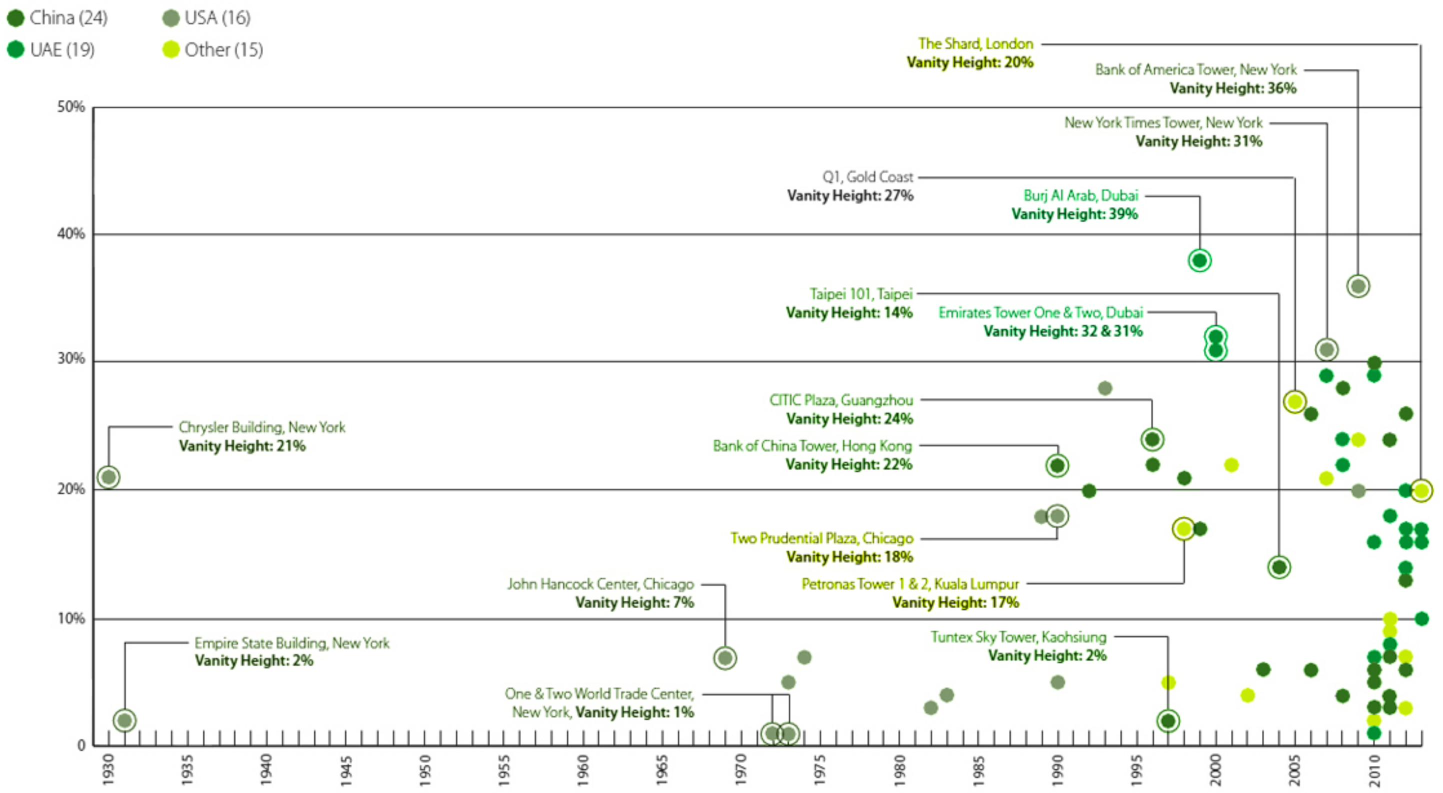
numbers and trends



[Fig.31] **Tallest Vanity Height in Detail** (data July 2013 CTBUH)

The graphs below examine the Vanity Height of completed supertalles by country, date of completion, and architectural height

'VANITY HEIGHTS'



[Fig. 32] **History of Vanity** (data July 2013 CTBUH)

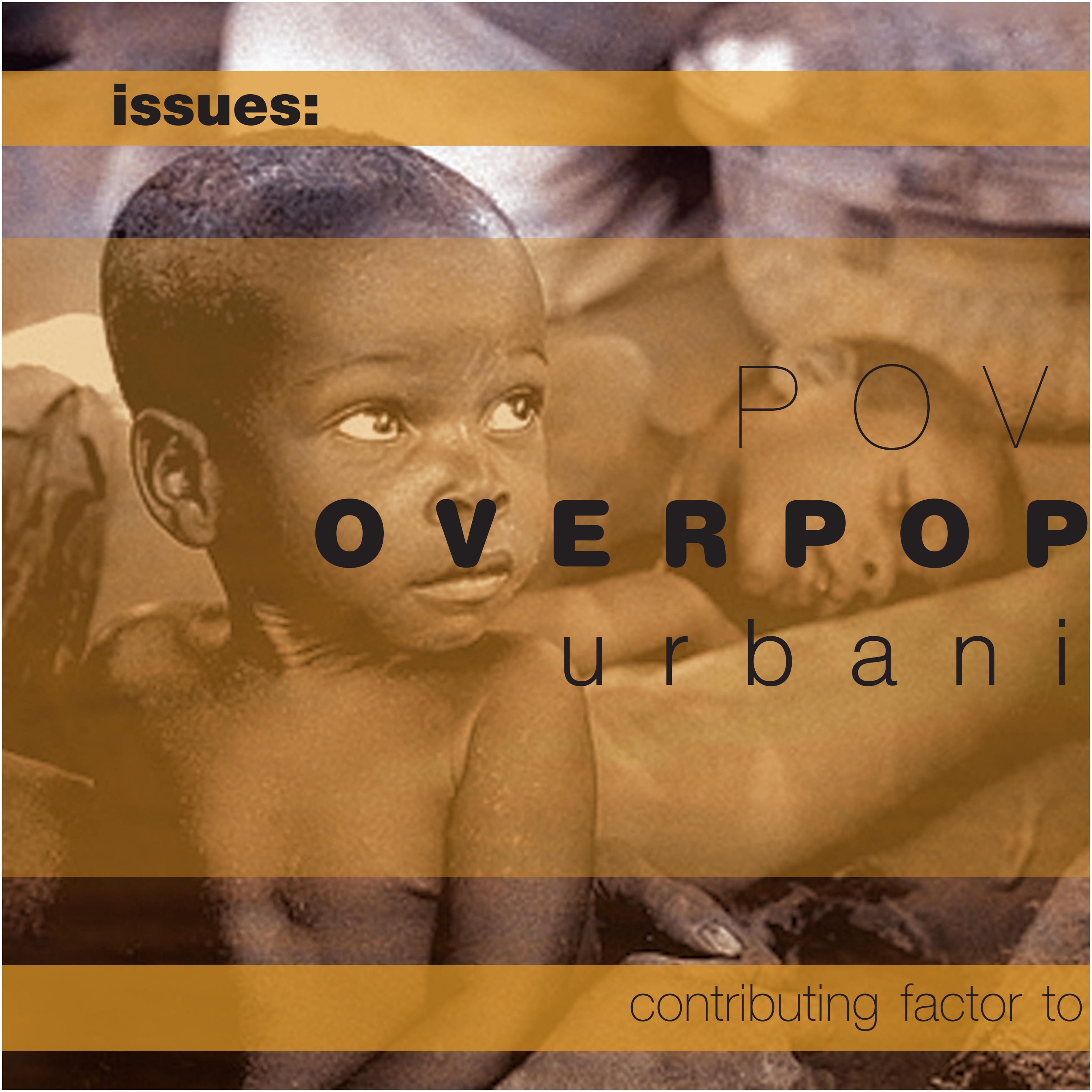
The graphs below charts Vanity Height as a percentage of overall architectural height for some of the world's 74 completed supertalls

issues

issues

The process of industrialization brought many technological achievements, innovations and advantages. Unfortunately, the process of production is still based on massive usage of fossil fuels, which induces continuous increase levels of CO_2 (carbon dioxide). Analyzes done during the last few decades prove the rapid warming of the Planet Earth. The modern science is still investigating this man-made impact on the environment. Predictions are pessimistic and the results may be fatal.

The greatest impacts on the increase levels of CO_2, amongst other factors, have transport and industry. The aim is to find design solutions to reduce energy consumed in building construction, and to decrease CO_2 emissions generated from building usage and construction processes.

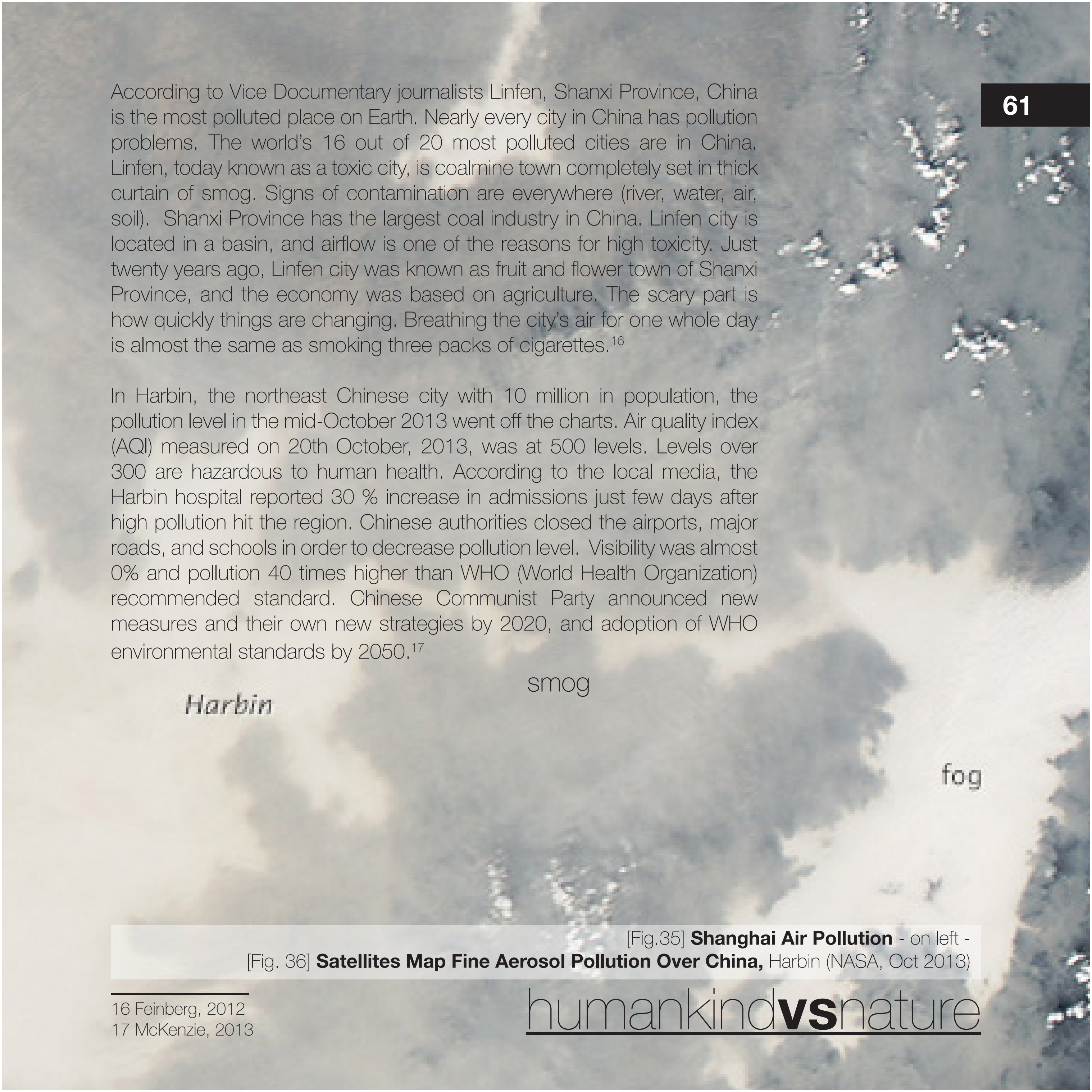

issues:
POV
OVERPOP
urbani
contributing factor to

[Fig.33] **Poverty in Africa** - on left -
[Fig.34] **Slums in South America**


environmental
issues
pollution
water
air
land
food and water scarcity
soil erosion
deforestation
toxicants
waste
climate change
fossil fuels consumption
global warming
greenhouse effect

According to Vice Documentary journalists Linfen, Shanxi Province, China is the most polluted place on Earth. Nearly every city in China has pollution problems. The world's 16 out of 20 most polluted cities are in China. Linfen, today known as a toxic city, is coalmine town completely set in thick curtain of smog. Signs of contamination are everywhere (river, water, air, soil). Shanxi Province has the largest coal industry in China. Linfen city is located in a basin, and airflow is one of the reasons for high toxicity. Just twenty years ago, Linfen city was known as fruit and flower town of Shanxi Province, and the economy was based on agriculture. The scary part is how quickly things are changing. Breathing the city's air for one whole day is almost the same as smoking three packs of cigarettes.[16]

In Harbin, the northeast Chinese city with 10 million in population, the pollution level in the mid-October 2013 went off the charts. Air quality index (AQI) measured on 20th October, 2013, was at 500 levels. Levels over 300 are hazardous to human health. According to the local media, the Harbin hospital reported 30 % increase in admissions just few days after high pollution hit the region. Chinese authorities closed the airports, major roads, and schools in order to decrease pollution level. Visibility was almost 0% and pollution 40 times higher than WHO (World Health Organization) recommended standard. Chinese Communist Party announced new measures and their own new strategies by 2020, and adoption of WHO environmental standards by 2050.[17]



[Fig.35] **Shanghai Air Pollution** - on left -
[Fig. 36] **Satellites Map Fine Aerosol Pollution Over China,** Harbin (NASA, Oct 2013)

16 Feinberg, 2012
17 McKenzie, 2013

the global WATER_c r i s i s

(data, 2009: http://water.org/)

1 IN 8 PEOPLE

DO NOT HAVE ACCESS TO CLEAN DRINKING WATER

2 MILLION

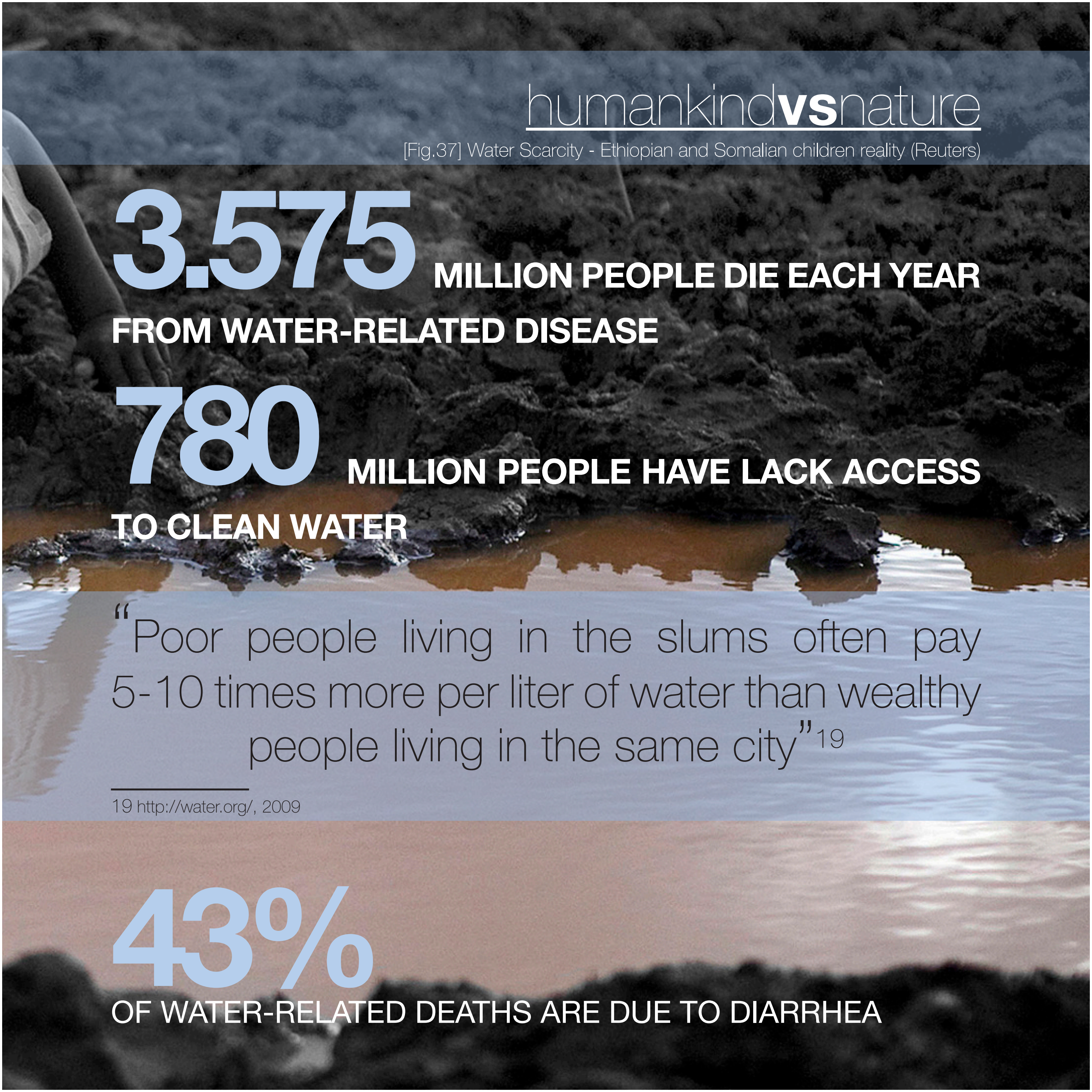
TONS OF HUMAN WASTE IS DISPOSED IN WATERWAYS DAILY

"[The water and sanitation] crisis claims more lives through disease than any war claims through guns."[18]

18 UNFPA, 2011

98%

OF WATER-RELATED DEATHS OCCUR IN THE DEVELOPING WORLD



[Fig.37] Water Scarcity - Ethiopian and Somalian children reality (Reuters)

3.575 MILLION PEOPLE DIE EACH YEAR FROM WATER-RELATED DISEASE

780 MILLION PEOPLE HAVE LACK ACCESS TO CLEAN WATER

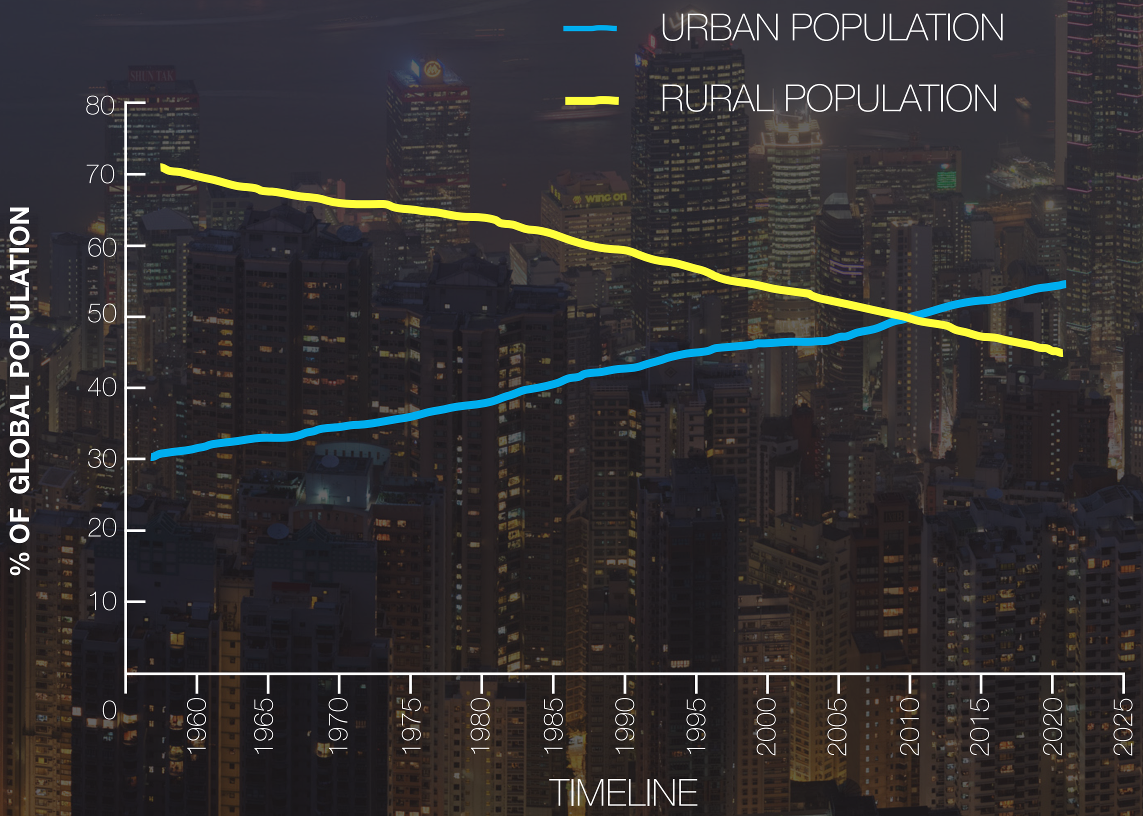
"Poor people living in the slums often pay 5-10 times more per liter of water than wealthy people living in the same city"[19]

19 http://water.org/, 2009

43% OF WATER-RELATED DEATHS ARE DUE TO DIARRHEA

More than a half of China's 1.3 billion people live on the countryside, and approximately 350 million Chinese people will move to the cities by 2030. Most of China is already connected to electricity grid, but many still use wood and coal for cooking and heating. Providing villages with electricity has brought more than 0,5 billion out of poverty.

In very short period of time, three billion people will start to use more and more energy as they escape from poverty. This is future scenario for Asia, South America and Africa.



[Fig.38] **PERCENTAGE OF TOTAL POPULATION LIVING IN URBAN AREAS** (WHO 2009)

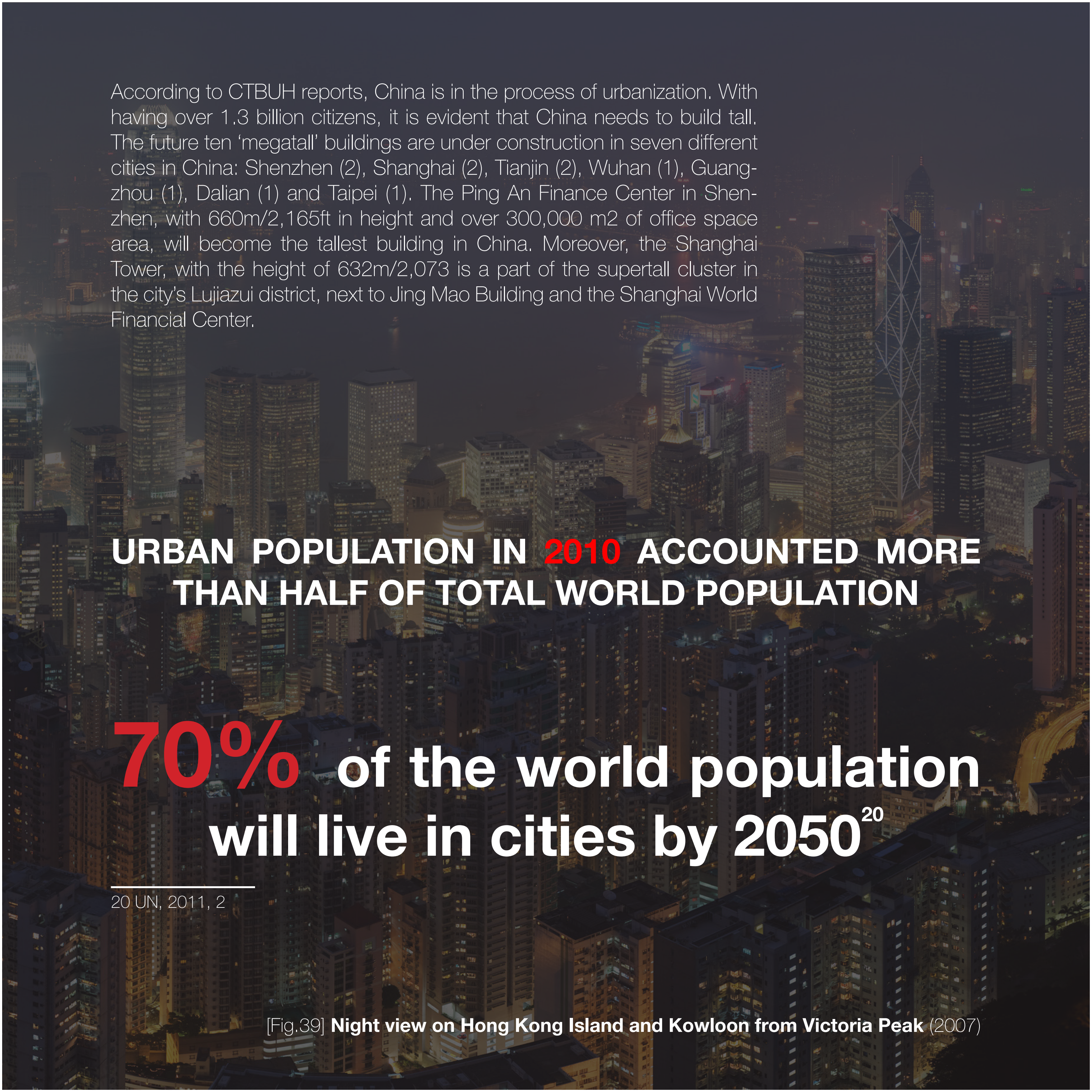
rural**vs**urban

According to CTBUH reports, China is in the process of urbanization. With having over 1.3 billion citizens, it is evident that China needs to build tall. The future ten ‘megatall’ buildings are under construction in seven different cities in China: Shenzhen (2), Shanghai (2), Tianjin (2), Wuhan (1), Guangzhou (1), Dalian (1) and Taipei (1). The Ping An Finance Center in Shenzhen, with 660m/2,165ft in height and over 300,000 m2 of office space area, will become the tallest building in China. Moreover, the Shanghai Tower, with the height of 632m/2,073 is a part of the supertall cluster in the city’s Lujiazui district, next to Jing Mao Building and the Shanghai World Financial Center.

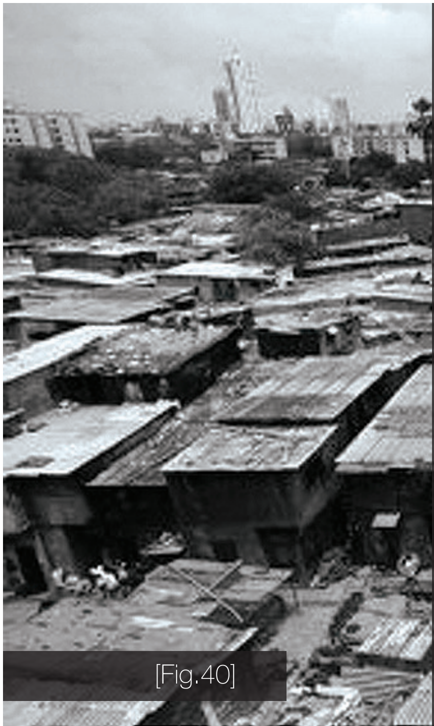
URBAN POPULATION IN 2010 ACCOUNTED MORE THAN HALF OF TOTAL WORLD POPULATION

70% of the world population will live in cities by 2050[20]

20 UN, 2011, 2



[Fig.39] **Night view on Hong Kong Island and Kowloon from Victoria Peak** (2007)



[Fig.40]

[Fig.41]

People across the southern hemisphere are moving from the countryside to the cities in order to find better living opportunities. Cities are well known as places where people have better access to everyday necessities, education, health care, job opportunities and a higher living standard. The world's largest cities will be in the developing countries of Asia, South America and Africa. Unfortunately, many countries have problems adapting to the flood of immigration from the rural areas. The cities have restricted space and lack of resources where density becomes a big issue. Oftentimes ignored and mistreated by the city and the country governments, many people are forced to organize living space in squatter settlements-slums on the city outskirts. Population living in slums is growing unchecked and unorganized.

The density of the slum, in this case, increases exponentially, causing very low living standard without having the basic needs like clean water, electricity and food.

"Over 90 percent of the slum dwellers today are located in the developing world. China and India together have 37 percent of all the world's slums. In the sub-Saharan Africa, urbanization became virtually synonymous with the slum growth; 72 percent of the region's urban population lives under the slum conditions, compared to 56 percent in the South Asia."[21]

<u>The five largest slums in the world</u>[22]:

1. Neza-Chalco-Itza, Mexico City, Mexico
2. Orangi Town, Karachi, Pakistan [40][42]
3. Dharavi, Mumbai, India [43]
4. Khayelitsha, Cape Town, South Africa
5. Kibera, Nairobi, Kenya [41]

21 UNFPA, 2007
22 Tovrov, 2011

[Fig.42]

[Fig.43]

After the Second World War and the Chinese Revolution in 1949, the refugees overcrowded the city of Hong Kong. This trend continued constantly in the following years. The result was creation of different squatter settlements on the city's margins, including the Kowloon Wall City.

According to the authors of the book: "The Making of Hong Kong: From Vertical to Volumetric" (Shelton/Karakiewicz/Kvan), in the time period between the 1950s and the 1960s, 25 % of Hong Kong's population was living in informal settlements, mostly in the single story squats. After the average increase of a half-a-million inhabitants in the five-year time period, between the 1951-1966, rooftops of many city buildings were inhabited as well. During that period, around 55,000-60,000 people, as believed, have occupied and created illegal dwellings on the rooftops of some city buildings. The roof become an informal reclamation project and in some cases the entire street blocks have been used as the "second ground". Under the necessity and population pressures, the Hong Kong people started to reclaim the air while the Hong Kong government reclaimed the sea.[23]

Disasters in the informal settlements were frequent, but the big fire on Shek Kip Mei on Christmas Eve in 1953 [15], when 53,000 people lost their homes, is remembered more than any other – for its size of the human tragedy and the effect on the future government policy.

First government response to complex situation were:

- "A massive resettlement scheme for squatters
- Public housing programs for poorer segments of society
- New building codex to encourage even more intensive redevelopment, and in turn, greater living densities" [24]

23 Vgl. Shelton/Karakiewicz/Kvan, 2011, 69.
24 Shelton/Karakiewicz/Kvan, 2011, 71.

Under those circumstances, to get control and to accommodate all the people without homes, Hong Kong's government made the first step into public housing. This practice was based on high-density living in organized buildings and estates. The first model was a modest structure, a six-story height H-block. Each unit was planned to accommodate five adult people, and it had 11.52 m2, with the occupancy ratio from 2,23 m2 per person, which is well below the space standards set by the United Nations.[25] Data from the 1965 show that just after ten years, 1 million or nearly one-third of the people were living in the public housing developments.

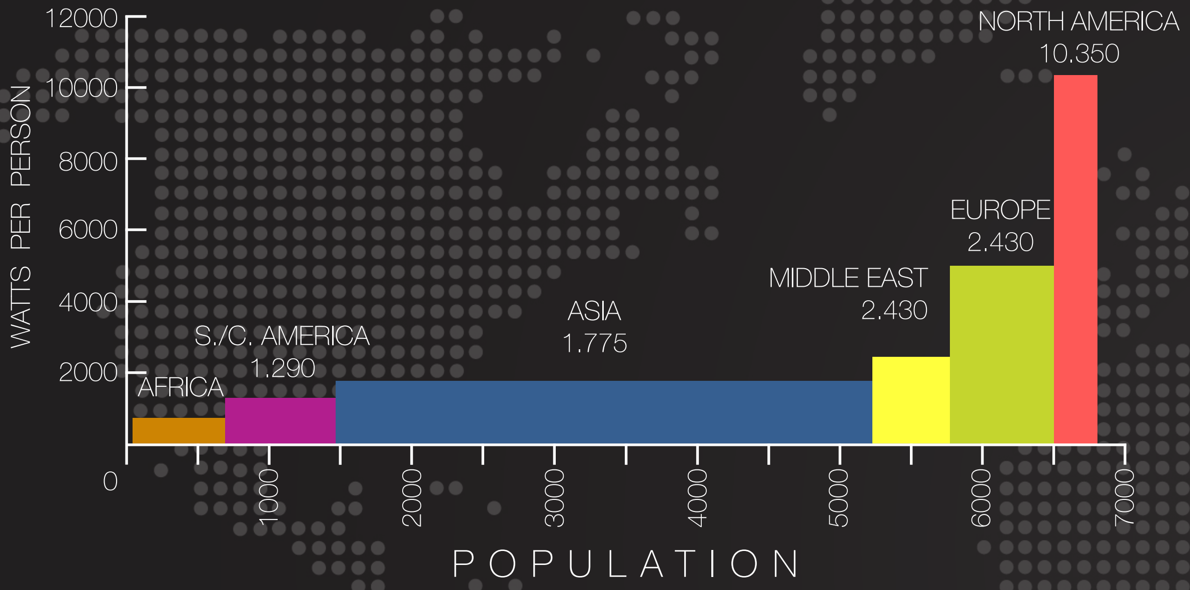
By 1981, several models of public housing have been successfully developed, and by that time, about 2 million people (2/5 of the Colony's population) have lived in public housing properties.

Public housing strategies and high density living was not strongly ideological for Hong Kong's government, but it was the pragmatic response to the problems and situation in the Colony.[26]

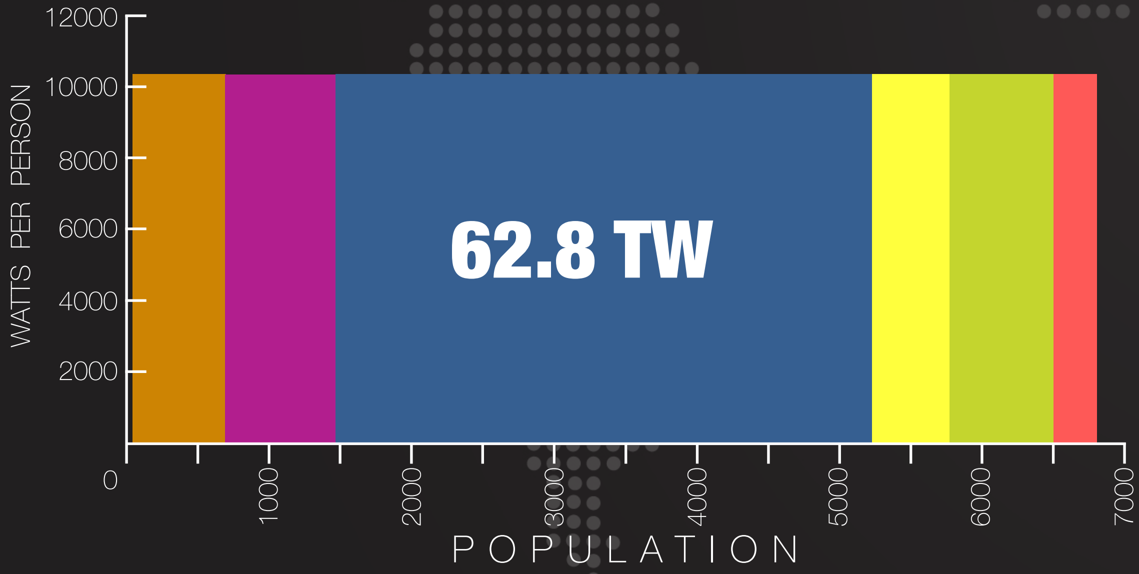
Because of these circumstances, Hong Kong has been shaped as a high-density city, with narrow and small footprint – 7 million people is settled on an urban land area of just 120km2 – approximately the concentration of 600 people per hectare, and next to Mumbai and Dhaka, makes one of the densest areas in the world.

25 Lim/Nutt, 2003, 51.
26 Vgl. Shelton/Karakiewicz/Kvan, 2011, 4.

[Fig.44] - on left - **The big fire on Shek Kip Mei**, Christmas Eve (1953)
[Fig.45] **Public housing estates in Shek Kip Mei in 50s and 60s**, North Eastern Kowloon, Hong Kong



[Fig.46] WORLD ENERGY USAGE IN WATTS PER PERSON



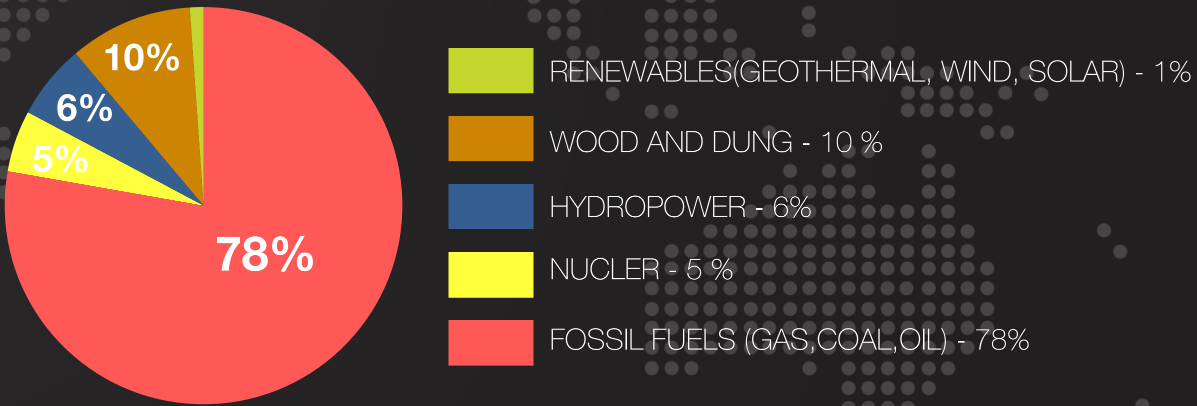
[Fig.47] EXAMPLE OF ENERGY CONSUMPTION BY THE WORLD ACCORDING TO NORTH AMERICA'S CURRENT USAGE

On April 11, 2011 PBS (Public Broadcasting Service) premiered documentary “Earth: The Operators' Manual” critically acclaimed on global changes and sustainable energy solutions. According to Richard Alley, host of the documentary and author of the book “Earth: The Operators' Manual”, people around the globe need to get involved in sustainability processes, as he optimistically clamed: “…we can avoid climate catastrophes, improve energy security, and make millions of good jobs.”

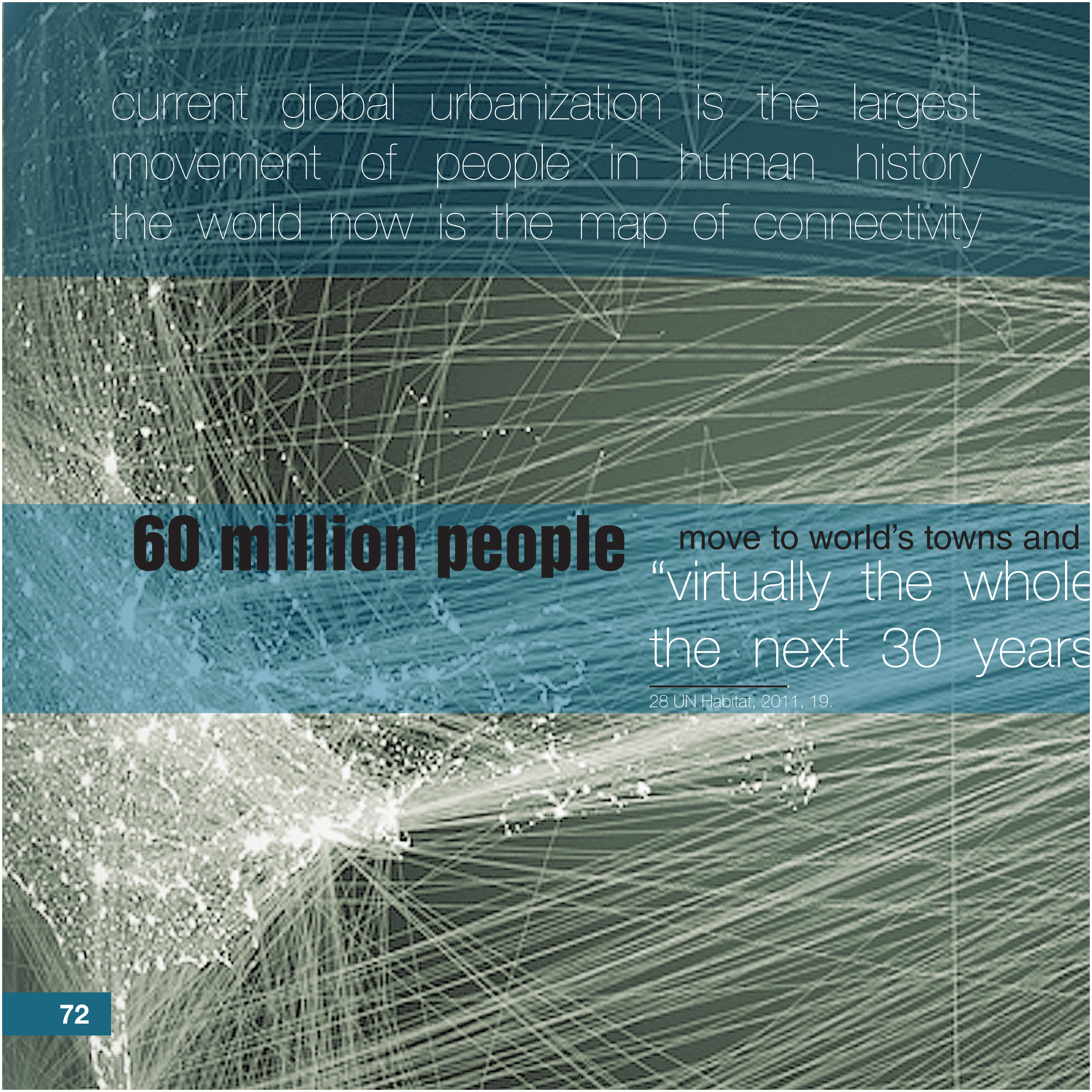
Some interesting data and corporations are presented in documentary “Earth: The Operators' Manual”. [46][47][48]

We are burning fossil fuels million times faster than nature can save it for us.[27]

27 Alley, 2012



[Fig.48] WORLD ENERGY CONSUMPTION



current global urbanization is the largest movement of people in human history the world now is the map of connectivity

60 million people move to world's towns and

"virtually the whole

the next 30 years

28 UN Habitat, 2011, 19.

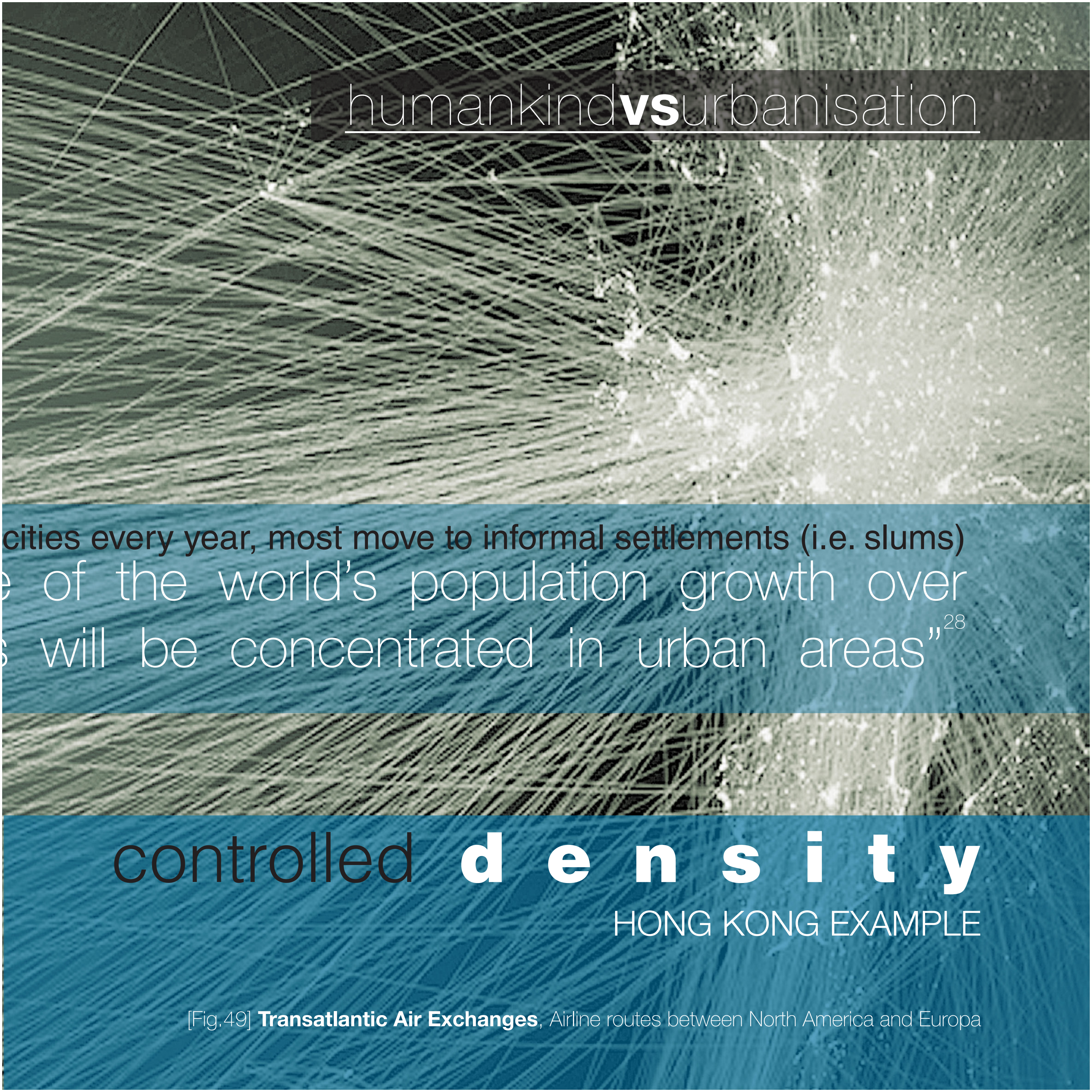
cities every year, most move to informal settlements (i.e. slums)

e of the world's population growth over

s will be concentrated in urban areas"[28]

controlled **d e n s i t y**

HONG KONG EXAMPLE



[Fig.49] **Transatlantic Air Exchanges**, Airline routes between North America and Europa

sustainability

sustainability

In the last few decades, we have been faced with the rapid climatic change that brought many catastrophic disasters. The questions to be answered are:

What can we do to change the outcome of that process, are we the ones who caused it by our selfish and uncaring behavior, and is it possible for us to rebuild the ecosystem of the Planet Earth?

Even though much has been said about sustainability in the last decade, for Norman Foster “sustainability is not a matter of fashion, but of survival.”[29]

Foster argues that sustainable architecture can be a tool to address the problem with using the least means, like noted in Miesian maxim ‘Less is more,’ or proverbial injunction ‘Waste not, want not.’

As previously mentioned, the world is denser than ever before, and this process is not going to end soon. Cities are increasingly faced with many changes and concerns: lack of land, resources scarcity, rising energy costs, climate changes and the possibility of future natural or man-made disasters.

The Report of the World Commission on Environment and Development stated that “sustainable development is not a fixed state of harmony, but rather process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and the institutional change are made consistent with future as well as present needs.“[30]

Williamson, Radford and Bennetts pointed out that the definition of sustainable development contains two crucial concepts. For them focus is on redefinition of “needs”, basic needs (food, shelter, clothing) and other needs that make life comfortable. “Secondly, it accepts the concept of ‘making consistent’ resource demands of technology and social organizations to meet the environments present and future needs.”[31]

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29 Foster 2001, 6.
30 UN Report of the World Commission on Environment and Development 1987, 15.
31 Vgl. Williamson/Radford/Bennetts 2003, 5.

SUSTAINABILITY AND SKYSCRAPERS

Until last decades, the tall buildings have been seen as major energy consumers for the city, due to increased size and vertical transportation, pump motors, lightning, shading.[32]

Luckily, planners, architects and public are slowly accepting the concept of sustainability. On the other hand, there are not yet any global regulations or specific actions put in place for resolving global issues.

Sustainability is considered to represent an emerging trend in tall building design. With the new generation of tall buildings, the development and utilization of modern technology is resulting in building a smarter energy-efficient building. Because of necessity, architects and engineers made innovative and pragmatic approaches to the basic structure and form, natural lightning and ventilation, program and materials, which in the end created an impact on aesthetic expression and the life cycles of tall buildings.

In order to reduce energy over consumption, strategies such as good access to daylight and wind are rapidly developing. In some cases elevators are reducing energy usage, and now they can even regenerate some electrical power. [33]

The aim is at zero-energy building design, with improved energy generation system, where energy needed for a building maintenance is produced and energy consumption is reduced. The whole process intended to have positive influence on environment and reduction of the global warming

32 Vgl. Gimbal/Firley 2011, 245.
33 Vgl. Gimbal/Firley 2011, 245.

[Fig.50] **Ecological Design In The Tropics,** EDITT Tower in Singapore by TR Hamzah & K.Yeang

impact.
Skidmore, Owings and Merrill (SOM) developed a new design approach for Pearl River Tower in Guangzhou, China. In order to achieve 'net zero energy', four related design steps have to be considered:

REDUCTION

ABSORPTION

RECLAMATION

GENERATION

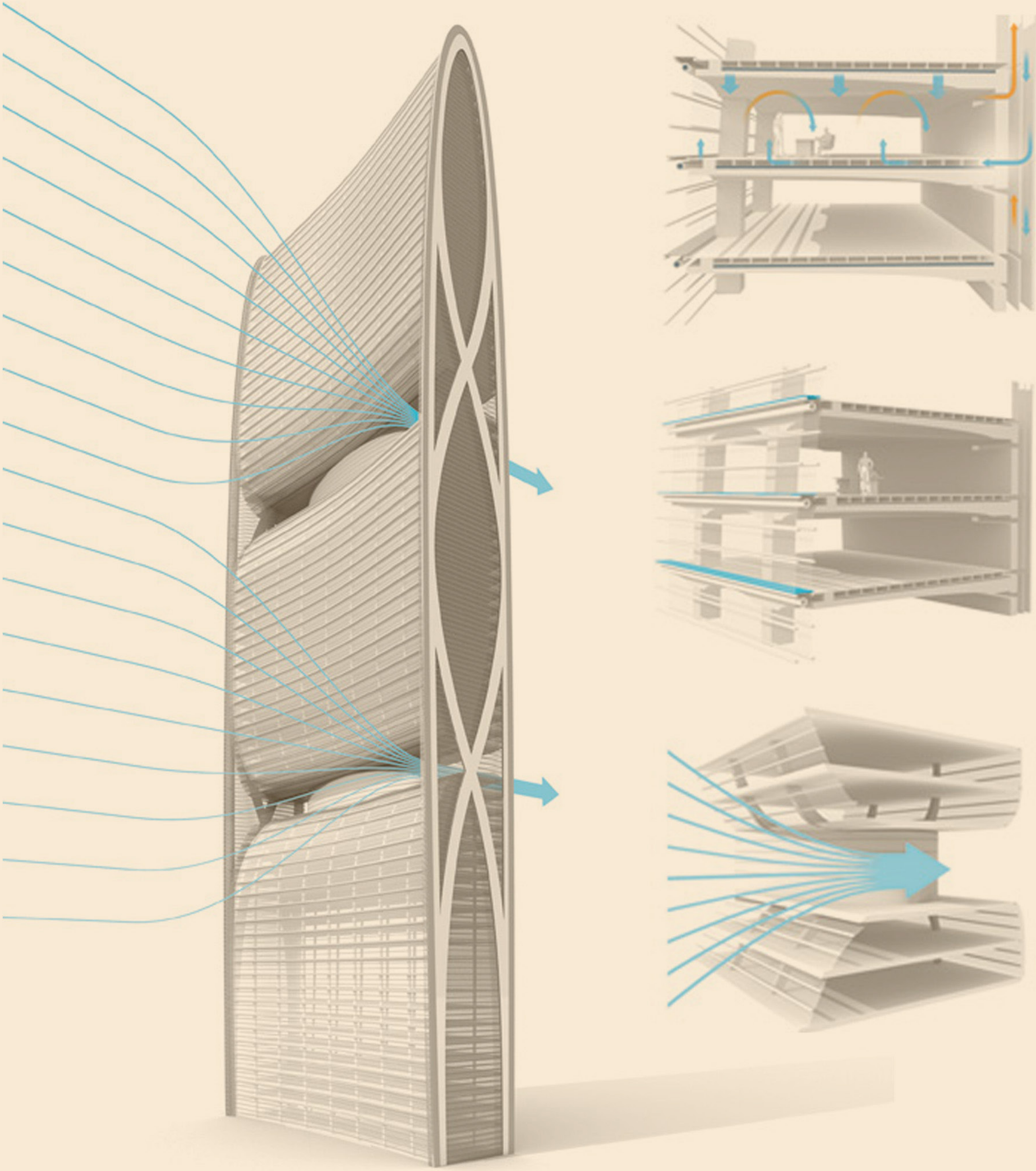
Reduction will provide minimization of the energy consumption with the focus on the largest group of energy consumers within the building, particularly the HVAC and the lighting systems. The methods include usage of ventilated high-performance active double wall façade with blinds, triple-glazed high performance façade, dehumidification system, low energy high efficient lighting system, "chilled" radiant ceiling system, and etc.

Absorption strategies will take the advantage of the natural and passive energy sources around the area, both of the inside and the outside building envelope by using a wide scale photovoltaic system, fixed external shades, daylight responsive controls, integrated vertical axis wind turbines, and etc.

Reclamation has an aim to harvest the energy within the building. Energy inside of the building can be used over and over again by using the re-circulated air for heat/cooling of the outside fresh air, and etc.

Generation is a concept that includes the use of "micro-turbine" gas turbine generation technology. The energy will be produced by the usage of micro-turbines, the efficient clean power in environmental responsibilities and generated within the building. Generated energy will be more efficient than the city's grid utilities. "A typical electric power utility grid is less than 30-35% efficient by the time the energy has reached the building [...]" [34]

34 Frechette/Gilchrist, 2008, 4.



[Fig.51] **Towards Zero Energy Architecture,** Pearl River Tower in Guangzhou by SOM (2011)

Many good ecological design solutions are combination of the newest technologies with building principles of forgotten traditions: the use of natural ventilation, wind flow, reflection of natural light to interiors, usage and filtration of rain, and etc.

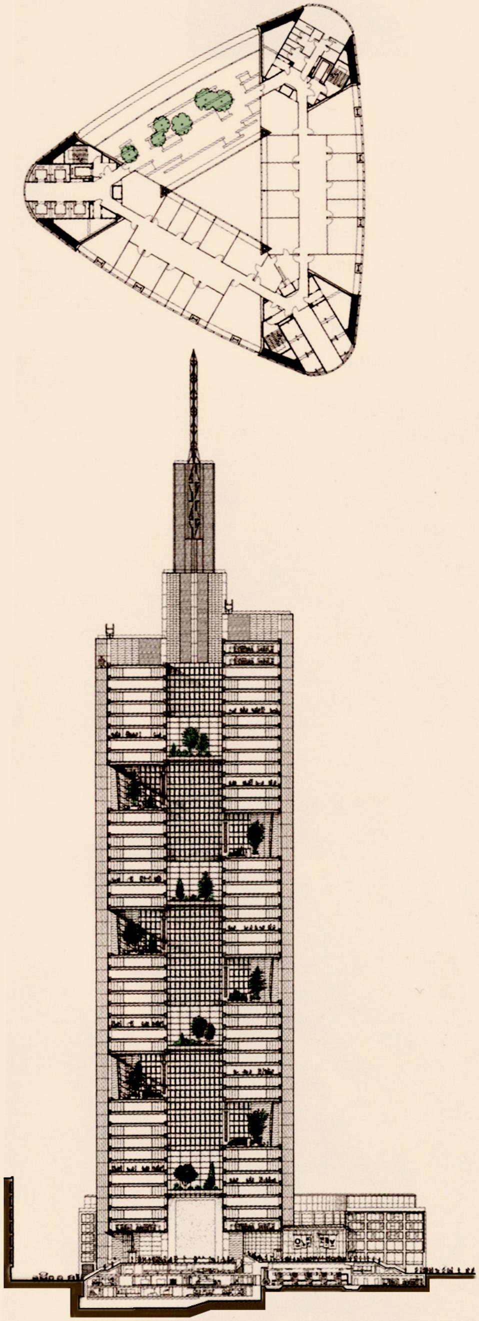
In their work, Ali and Armstong stated that many designers and planners have examined some historical sources, in particular the vernacular architecture, when searching for designs that incorporate sustainability. They discovered that so-called passive systems of climate control facilitated by vernacular architecture builders, like shading or using natural ventilation and plantings, are actually the same components that are being integrated into 'green' type buildings.[35]

According to Sun Woo Shin "Sustainability is concept that requires the integration of environmental, economical and societal dimensions for intergenerational equity. "[36]

Collaboration with clients, investors and public is crucial for defining and developing a vision of sustainable design. Design teams of architects, planners and engineers have to research and analyze many different impacts on building (location, climatic and weather data, position and urban integration of object, connectivity and transportation, culture, tradition and politic…), clearly starting with definition of needs, functions and program. Finally, the design will effect aesthetic expression and form, structure, materials, services, mechanical systems, façade technologies, and etc.

The Sustainability and the Tall Building report mentioned 'vertical garden cities' as a construction style for tall buildings in order for better usage of urban space and resources, making the building more efficient and user-friendly. The report warned that much consideration is needed in making future sustainable high-rise buildings because of the emphasis on multi-functionality of a building that consolidates working, retail and leisure spaces into a single building.[37] With Ken Yeang's ecological designs, Norman Foster simple mechanical and technological solutions, Skidmore,

35 Ali/Armstrong 2010, 2.
36 Ng 2013, 298-299.
37 Ali/Armstrong 2010, 11.

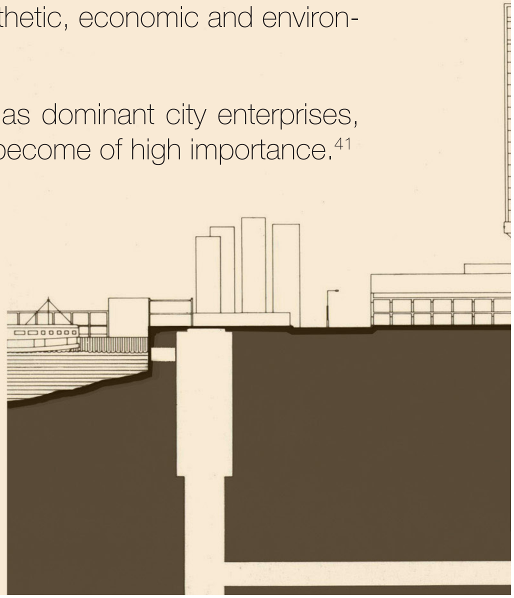


[Fig.52] **Additional Spatial Complexity,** Internal Courtyard, Commerzbank Frankfurt by Norman Foster (1997)

Owings and Merrill (SOM), KPF, OMA and many other famous architects projects' are demonstrating that skyscrapers can be environmentally friendly, energy-efficient and related to their site and culture. Armstrong and Ali recognize that in those buildings you can find the same amenities that are founded in the city, like the "sky gardens within buildings that contribute to interior air quality by filtering pollutants." [38]

Norman Foster reflects that "Our buildings have always been driven by a belief that the quality of our surroundings directly influences the quality of our lives, whether in the workplace, at home or in the public spaces that make up our cities."[39] He explains that this emphasis on the social dimension actually proves that architecture is generated by people's material and spiritual needs. Importance of analyses and action is crucial for the process, as well as method of asking right questions. "[…] it means never taking anything for granted, always trying to probe deeper. This is due in part to a fascination with inquiry, with going back to first principles to identify whether there is an opportunity to invent, or re-invent, a solution." Furthermore, he observes: „[…] It is not only individual buildings but also urban design that affects our well being. A concern for the physical context has produced projects that are sensitive to the culture and climate of their place. We have applied these priorities to public infrastructure projects worldwide – in our airports, railway stations, metros, bridges, telecommunications towers, regional plans and city centers. For me the optimum design solution integrates social, technological, aesthetic, economic and environmental concerns." [40]

Al-Kodmany and Ali, consider tall buildings as dominant city enterprises, where urban design and sitting of buildings become of high importance.[41]



38 Ali/Armstrong 2010, 5.
39 Foster 2003, 1.
40 Foster 2003, 1.
41 Vgl. Al-Kodmany/Ali 2013, 2.

The long tunnel between harbour and The HSBC Building (Hong Kong) is providing water from the see, for air cooling and flushing water (approximately 1000 liters of see water per second)

[Fig.53] **The Tower and Urban Surroundings,** HSBC Headquarters by Foster and Ove Arup (1985)

SUSTAINABILITY, SKYSCRAPERS AND THE CITY

Developed world is facing the problem of building's energy consumption, where half of world's energy resources goes on building usage, with transport taking on everything that is left. Even though, architects have no exclusive power to save world's ecological problems,they can design buildings that run efficiently and could influence transport patterns through the urban planning.[42]

The questions raised by Krummeck is "how do these tall building relate to urbanism and how are they located in their urban surrounding?"[43]

Krummeck further explains that compared to modernistic approach, were building was standing isolated in a transparent open space, the actual site has surrounding environment and its own season, social and cultural climates. Krummeck stated that many think how low and high-rise buildings should not be isolated against surrounding environment, but to include both buildings and the space between them as the urban context suggests. [44]

Ali and Armstrong made it clear that one needs to consider the relationship between tall buildings and their urban infrastructure, where transportation systems, water and waste distribution, energy, heating and cooling must be recognized as means by which sustainable design can be impacted. [45] Compact and sustainable tall building design can lead to sustainable city on a macro level by curbing urban sprawl. This design principle could reduce energy use and carbon discharge and increase city's sustainability levels.

"When we compare the land use and energy requirements of high-rise building to a small city, the advantages of concentrating people and

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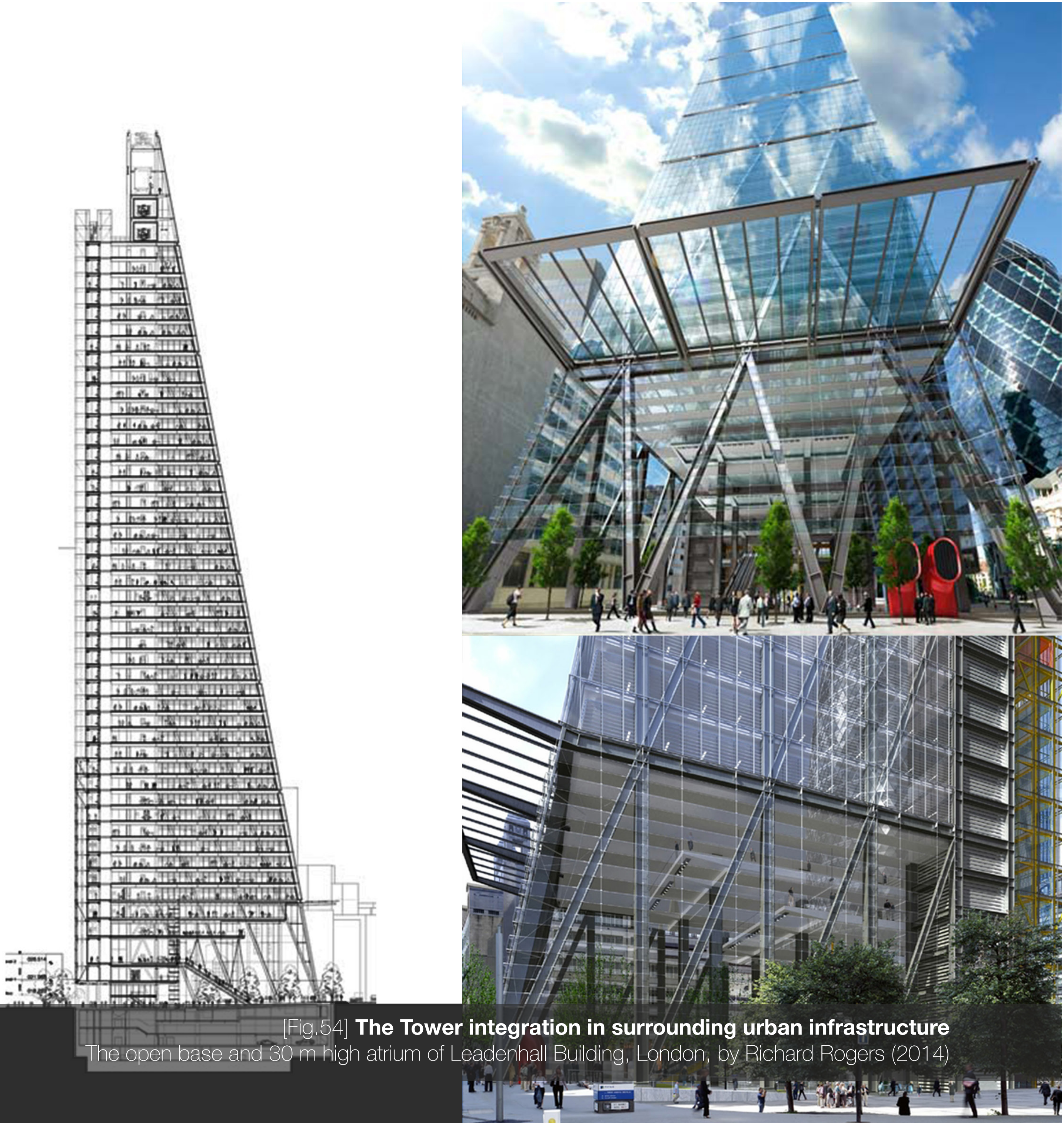
42 Vgl.Foster 2003, 3.
43 Krummeck 2010, 5.
44 Vgl. Gutierrez/Portefaix 2003, zit.n. Krummeck 2010, 6.
45 Vgl. Ali/Armstrong 2010, 2.



[Fig.54] **The Tower integration in surrounding urban infrastructure**
The open base and 30 m high atrium of Leadenhall Building, London, by Richard Rogers (2014)

services into a vertical city becomes evident.” [46]
Norman Foster stated that the aim of sustainable architecture is to accompany the trend of expanding cities and their infrastructures, and to find the solution for the unchecked urban sprawl that is one of the main problems in the world today. Foster claims that our cities grow horizontally rather than vertically making a greater distance for people to travel between home and work. Foster found that between 1900 and 2000, “the average distance travelled by an individual per day in Britain increased from 1.5 miles to 25 miles.” In Britain today 90 % of all shopping trips are made by car, according to Foster’s article. It shows that a direct correlation between urban density and energy consumption exists, where smaller and denser cities promote walking and cycling versus driving. Foster took Copenhagen and Detroit as comparison cities, and stated that while both cities have roughly the same population size and are similar in climatic conditions, it is interesting to know that a person living in Copenhagen consumes around 10 % of the energy consumed by his or her counterpart in Detroit. The reason for it, Foster thinks, lies in the fact that people are largely more dependable on cars in Detroit because of its 39.2/km2 of population density compared to Copenhagen’s 122.4/km2. [47]

“Compact urban form means intensification and densification, mixed land uses, efficient transport, and street and pathway planning that encourage walking and biking.”[48]

Many authors reported on positive macro picture of a compact city. Gimbal and Firley reflect that more compact high-rise city is less dependable on individual transport over spread out city with low-rise buildings that required road connectivity and individual transport.[49]

Foster argues “high-urban density leads to improved quality of life when housing, work and leisure facilities are all close by.“ He explained that high density does not always assume economic hardship or overcrowding. To him, great example can be found in Monaco and Macao, two of the densest populated world’s regions that exemplify opposite points of the

46 Ali/Armstrong 2010, 5.
47 Vgl.Foster 2003, 3.
48 Al-Kodmany/Ali 2013, 2.
49 Gimbal/Firley 2011, 245.

[Fig.55] **Compact Urban Form**
Aerial Panorama over Hong Kong Island shows compact urban form of Hong Kong

economic spectrum. Also, London's Mayfair, Kensington and Chelsea fit in the same observation, being one of the most expensive and most densely populated areas, with population of 35,000 people per square km which makes them somewhat 10 times higher than some poor neighborhoods. [50]

"How do such buildings meet the ground where they make significant impact on the urban fabric? "[51]

The concept of density is deeply related to urban integration, or more precisely influenced of high-rise to his surroundings. In the other way, it is interesting to observe a reflexive concept, impact of surroundings to the tower. Similarly, it is also interesting to observe what is called the reflexive concept, the impact of surroundings on the tower itself.

"In all cases, the successful insertion of the tower will depend in part of ability of its occupants to find fundamental amnesties at the foot of the building. It may seem natural to assume that locating the tower in a dance urban fabric will automatically solve this point. However, the challenge can in fact remain even when building in an already dance urban fabric: the local neighborhood could already be saturated and unable to cope with the sudden influx of people associated with the tower."[52]

The design of an approachable access to the tower is a complex task, because in order to find an effective solution for the problem, location of main entrances for users and the public and the role of 'back' entrances for logistics of the building must be considered.

Firley and Gimbal pointed out that the best solution to the problem of access to the tower is to provide a substantial amount of space to accommodate population peeks, and it can be done within the base of the tower or its close distance. They also elaborate on another effective method for this problem, which considers an establishment of orderly procession of space that facilities orientation of the base, clear sight of the reception desks, elevator banks and street exits. The use of monumental stairs and escalators to separate and control population is often used as a multi-level

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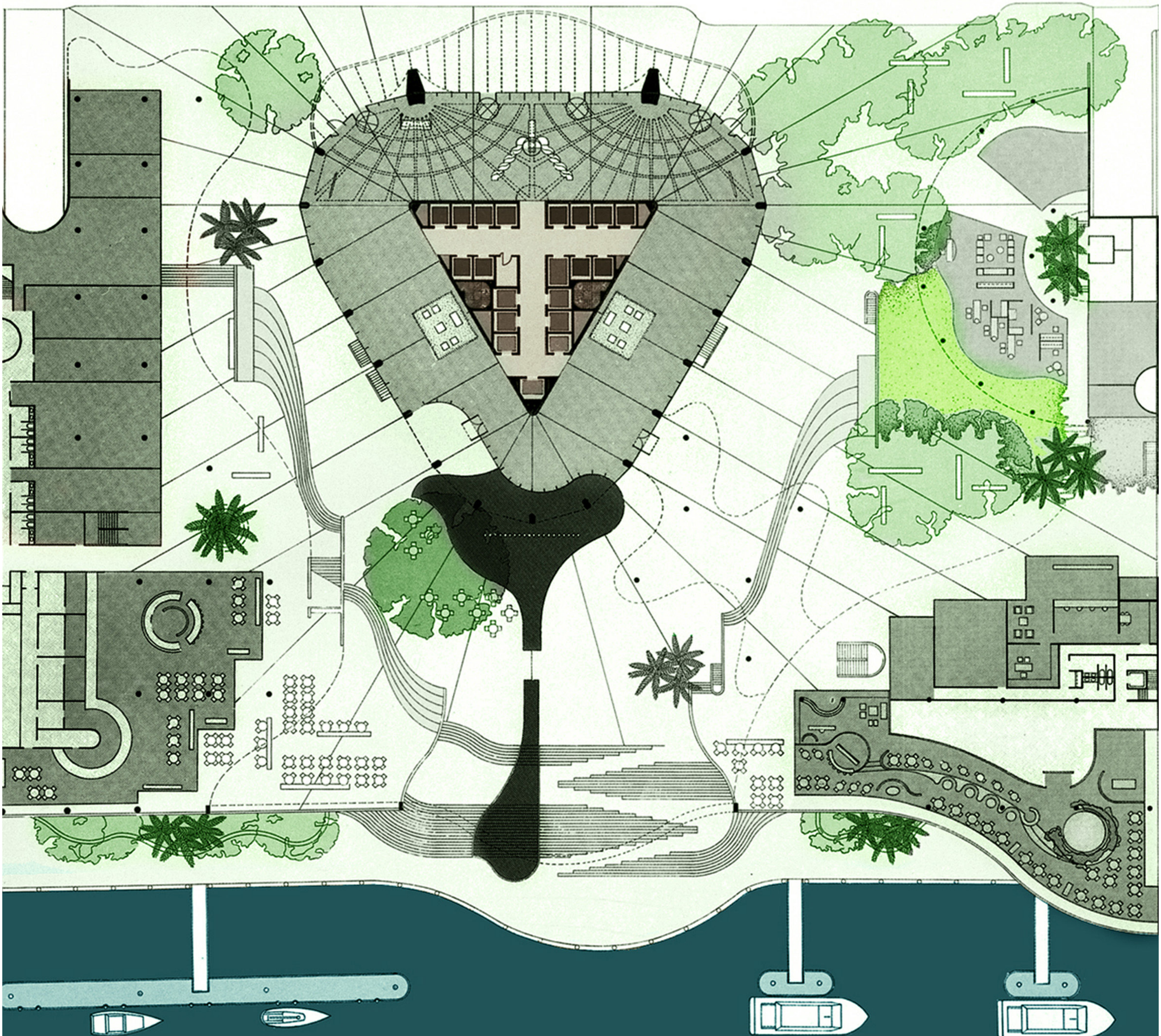
50 Vgl.Foster 2003, 3.
51 Krummeck 2010, 7.
52 Firley/Gimbal 2011, 241.



[Fig.56] **Riverside Development, Brisbane,** by Harry Seidler (1986)
contrary to the stereotypical typologies, creating new public realm and urban spaces around the tower base

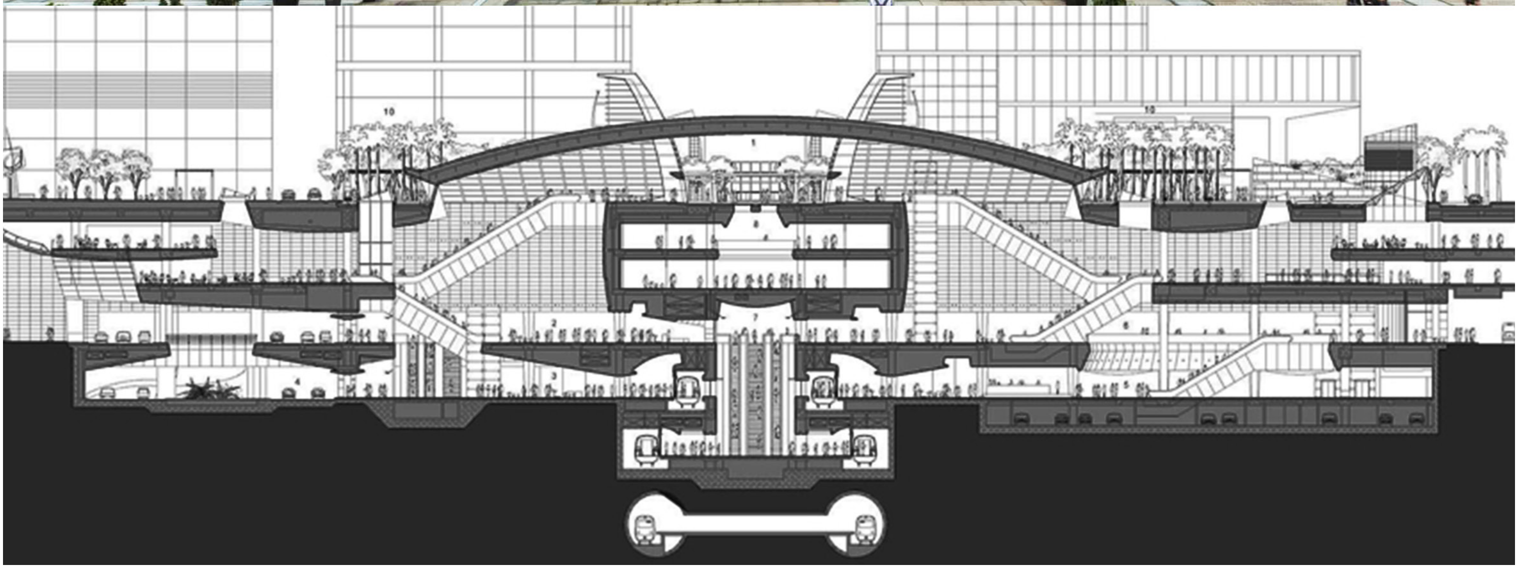
solution. [53]

In case of twin towers or tower clusters, open space for plazas between them is required, for transition and connection, orientation or open public space. Well-planned position of access brings many positive influences for user and day-to-day building operation. For user acceptance in the wider urban context, towers need to demonstrate the flawless connectivity with public transport and road networks. [54]

In locations like Hong Kong, strategic plan was implemented to connect subway station and high-speed train station as part of the larger tower development. “The concept of turning the area into a transport “super city” was the basis of the development of a number of tall buildings including the International Commerce Centre mega tower (formerly known as the Landmark Tower). Those buildings sit directly on top of the Kowloon station with both metro and airport rail connections.”[55] Krummeck observes that strategy solution is to introduce separate functional layers forming a podium, on top of mass transportation system. Furthermore, he explains importance of integration, ‘balanced city’, where numerous functions are linked together, such as flats, offices, community facilities, hotels and service apartments that are directly connected with air-conditioned shopping streets, public areas in podium levels, gardens, squares and pedestrian paths. He argues that the compact composition provide accessibility, efficiency and convenience for visitor and users. Expressed differently, this represents vertical city, a horizontal development on the podium (retail, parking, recreational and transport facilities).[56] On the other hand, “tall buildings can act as ‘beacons’ expressing economic success.”[57] Tall buildings, seen as a ‘beacon’ in the city, represent symbol of progress, economic growth and prosperity. The design of those buildings is not only set by functional considerations, but it has to respond to high standard of social and urban complexity to the neighboring site.

Krummeck concludes that mixed and diverse functionality gives new

53 Vgl. Firley/Gimbal 2011, 243.
54 Vgl. Firley/Gimbal 2011, 243.
55 Krummeck 2010, 7-8.
56 Vgl. Luk 2006, zit.n. Krummeck 2010, 8.
57 Krummeck 2010, 9.



[Fig.57] **West Kowloon Station,** Hong Kong
[Fig.58] **West Kowloon Station,** cross section

dimension of today's tower typology. "Skyscrapers can either be developed as signifiers, as urban hubs, or as beacons in the city".[58] He assumes that the final aim is to create three-dimensional and absorptive buildings in the city, and not only for competition to reach higher heights. Architects, planners and designers, as he believes, need to create more energy-efficient buildings, with greater solar, wind and seismic solutions.

In order to accomplish the goal of demonstrating a sustainable city, the public realm and political strategies must be well connected. Planning decisions need to be discussed on a political level, especially in terms of supporting the crucial infrastructure projects, development of transportation networks and airports.

Ali and Al-Kodmany noted that even the 21st century is no exception to set of unique challenges that it faced. Issues for cities today are wide range, from climate change, massive pollution, dwindling natural resources, excessive urban population, and congestion, and economic hardship to social and political unrest. It is well know that there is a shift in global economy from the West to the East. While struggles of the East are increasing urban population numbers, the West has to find ways to rehabilitate aging urban infrastructure. Nowadays, even modern cities engage with the concept of sustainability. Reasons for this rapid shift in thinking could be found in globalization and global competition that are spreading worldwide. Their effects are major push for urban designers, planners and architects to develop new ideas and find innovative solutions to ensure that the future cities have better urban environments and can offer better quality of life to its citizens. [59]

Abel concluded that other research on this topic, is very important and needs to be incorporated into planning and design processes of the tall buildings because of the sustainability aims, in order to better predict the cycle costs, energy use and the impact tall buildings have on their urban habitats. [60]

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58 Krummeck 2010, 10.
59 Vgl. Al-Kodmany/Ali 2013, V
60 Abel 2010, 11.

[Fig.59] **Linked Hybrid Building,Beijing,** by Stiven Holl (2009)
horizontal and vertical links between many structures

Authors Gimbal and Firley, in the book “The Urban Towers Handbook”, reported the result of comparison between two extreme urban areas, such as Greater Los Angeles Area and Manhattan, which is a good example and illustration point how compact urban fabric consume less energy. According to data from the 2000 US Census, Manhattan density is approximately 26.000 people per square kilometre and Greater Los Angeles Area density is slightly lower approximately 2.700 people per square kilometre. The US Department of Energy acknowledges data for 2008 in which New York State has one of the lowest per capita energy consumption in the USA, 205 million BTU[61] (60079.56kWh) compering to California’s 229 million BTU (67113.27 kWh) per capita energy consumption, which is relatively low, due to mild weather that reduces energy consumption needed for heating and cooling. New York consumes less than California, regardless of harsher weather conditions, due to positive impact of public transport, compact and smaller house units, compering to Los Angeles area of low-rise suburban sprawl and road connectivity requirement. [62]

61 The British thermal unit is a traditional unit of energy equal to about 1055 joules. Online in Internet: http://en.wikipedia.org/wiki/British_thermal_unit
62 Gimbal/Firley 2011, 245.

[Fig.60] **Manhattan at night,** positive example of high density living

[Fig.61] **Los Angeles urban sprawl,** road connectivity requirement

chronology

BUILT PROJECTS
UNBUILT PROJECTS

1922 Le Corbusier Contemporary City for 3 million
1924 Ludwig Hilberseimer, Vertical City
1924 El Lissitzky, Wolkenbugel
1925 Kiesler, City in Space
1927 Richard Neutra, Rush City Reformed
1928 Chernikov, City of the Future
1926 Fritz Lang, Metropolis
1928 Walter Gropius Wohnberg
1928 Henri Sauvage Metropolis
1931 Raymond Hood City Under a Single Roof
1929 Le Corbusier Rio de Janeiro
1930 Le Corbusier Plan Obus Algiers

1916 **Giacomo Matte-Trucco, Fiat Lingotto**

1917 Tony Garnier, Cite Industrielle

1919 Virgilio Marchi, Citta Superiore

1945 **Le Corbusier Unité d'Habitation Marseille**

1919-1921 Brinkman Spangen, Wohnhof

1956 Frank Lloyd Wright,
Mile High Building

1906 Theodore Garrett,100 Story Building

1934 Frank Lloyd Wright, Broadacre City

1910 1920 1930 1940 1950

1909 Walker, Skyscraper

1947 Affonso Reidy Pedregulho

1908 Moses King The Cosmopolis of the Future
1908 William R Leigh, Visionary City

1931 Tullio Crali Urban Airport
1931 Hugh Ferriss Metropolis of Tomorrow
1931 Raymond Hood Manhattan 1950

1910 Eugene Henard, Future Cities

1913 Harvey W Corbett, New York Future

1934 Frank Lloyd Wright Broadacre City

1914 Antonio Sant'Elia, La Citta Nuova
1914 Mario Chiattone, Modern Metropolis

1951 Alison & Peter Smithson, Golden Lane
1951 Le Corbusier, Chandigarh

chronologie_

1958-1988 **EPAD, La Défense**
1958 Walter Jonas, Intrapolis
1959 Solieri, Mesa City

1962 Constant, New Babylon
1963 Chalk&Herron, Cityinterchange
1963 Cock, Plug -InCity

1964 Herron, Walking City
1964 Chalk, Underwater City
1964 Solieri, Hexahedron
1964 Solieri, Babelnoah

1984 **Leon Krier, New urban Quarter la Villette**

1967 Rudolph, Graphic Arts Centre
1967 Safdie, Habitat NY
1968 Safdie, Habitat Puerto Rico

1999 MVRDV, Km3

1963-67 **Safdie, Habitat '67**
1959-1975 **Chamberlin Powell & Bon, The Barbican**

2001 MVRDV & BIR, Km3

1970 **Bofill, City in Space**
1970 Parent & Virilio, Bridge Cities

2002 MVRDV, Kissing Towers

1959-67 **Goldberg, Marina City**
1975-86 **Vasconi & Pancreach, Les Halles**

2002 NOX, Obique WTC
2002 FOA, Bundle Tower
2002 SOM & SANAA, WTC
2002 United Architetcs, WTC
2002 Holl, Folded Street, WTC

1961-75 **Candilis Josic & Woods, Toulouse-Le-Mirail**

1962-today **Montreal Underground City**
1962-today **Baker, Minneapolis Skyways**

1960 **1970** **1980** **1990** **2000**

2002 **Holl, Linked Hybrid**

1965-70 **SOM, John Hancock**
1966 SPUR, Asian City of Tomorrow

1989 Tokyu, Geotropolis
1989 Harada, Sky City
1989 Foster, Millenium Tower

1969-now **Toronto PATH**
1959 Tange, Boston Harbor

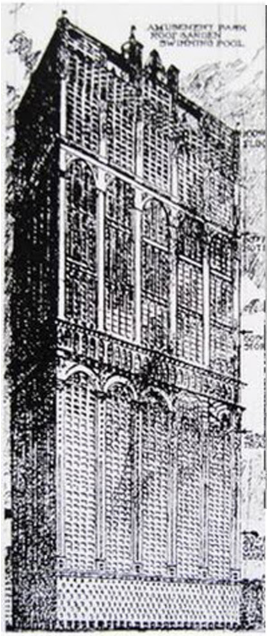
2002 **ARC Studio, Duxton Plain**

1991 Shimizu, Megacity Pyramid
1991 Tsui, Ultima Tower
1992 Hara, 500m cube
1995 Taisei, X-Seed 4000
1996 Solieri, Hyperbuilding
1994 Harada, Hyperbuilding
1996 OMA, Hyperbuilding
1996 Furuya, Hyperbuilding

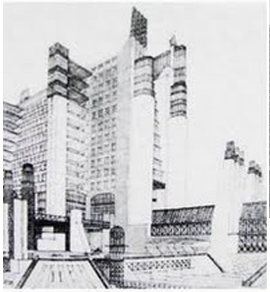
1970 Rudolph, Lower Manhattan Expressway
1970 Solieri, Arcosanti

1960 Tange, Tokyo Bay
1960 Isozaki, Space City
1962 Isozaki, Clusters in the air
1961 Kurokawa, Hellcoids

1906
Theodore Garrett
100 story Building

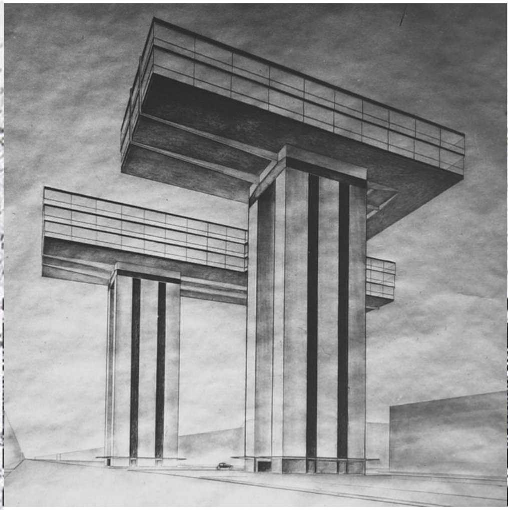


1914
Antonio Sant'Elia
La Citta Nuova

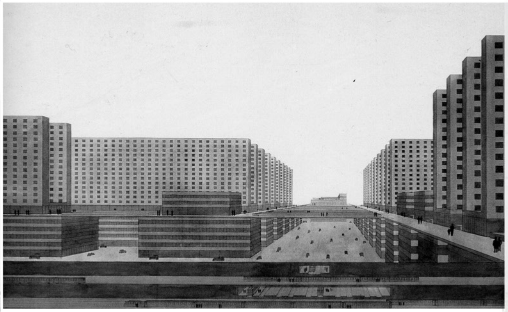


1914
Mario Chiattone
Modern Metropolis

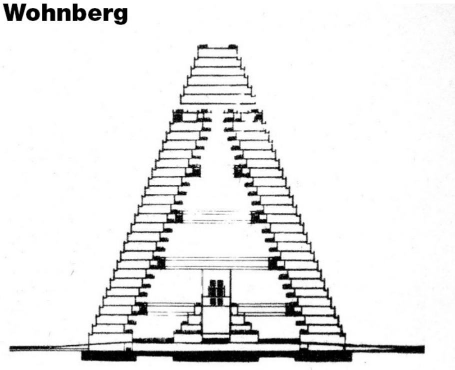
1924
El Lissitzky/ Stam/ Roth
Wolkenbugel



1924
Ludwig Hilberseimer
Vertical City

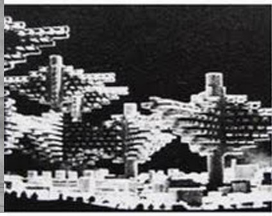


1928
Walter Gropius
Wohnberg



1928
Henri Sauvage
Metropolis

1962
Arata Isozaki
Clusters in the air

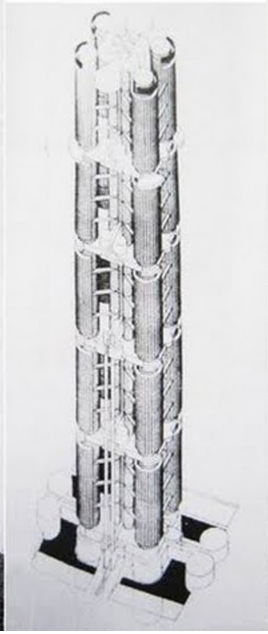


1956
Frank Lloyd Wright
Mile High Building

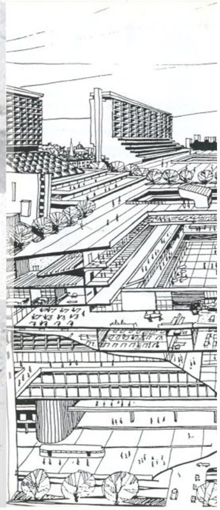
1964
Paolo Soleri
Hexahedron

1964, Fuller
Harlem
Redevelopment

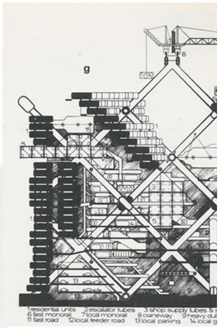
1965
St.Florian
Vertical City



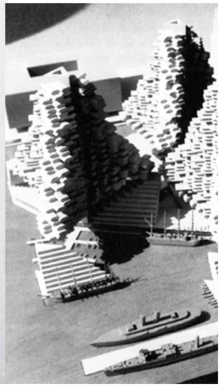
1966
SPUR
Asian City of T

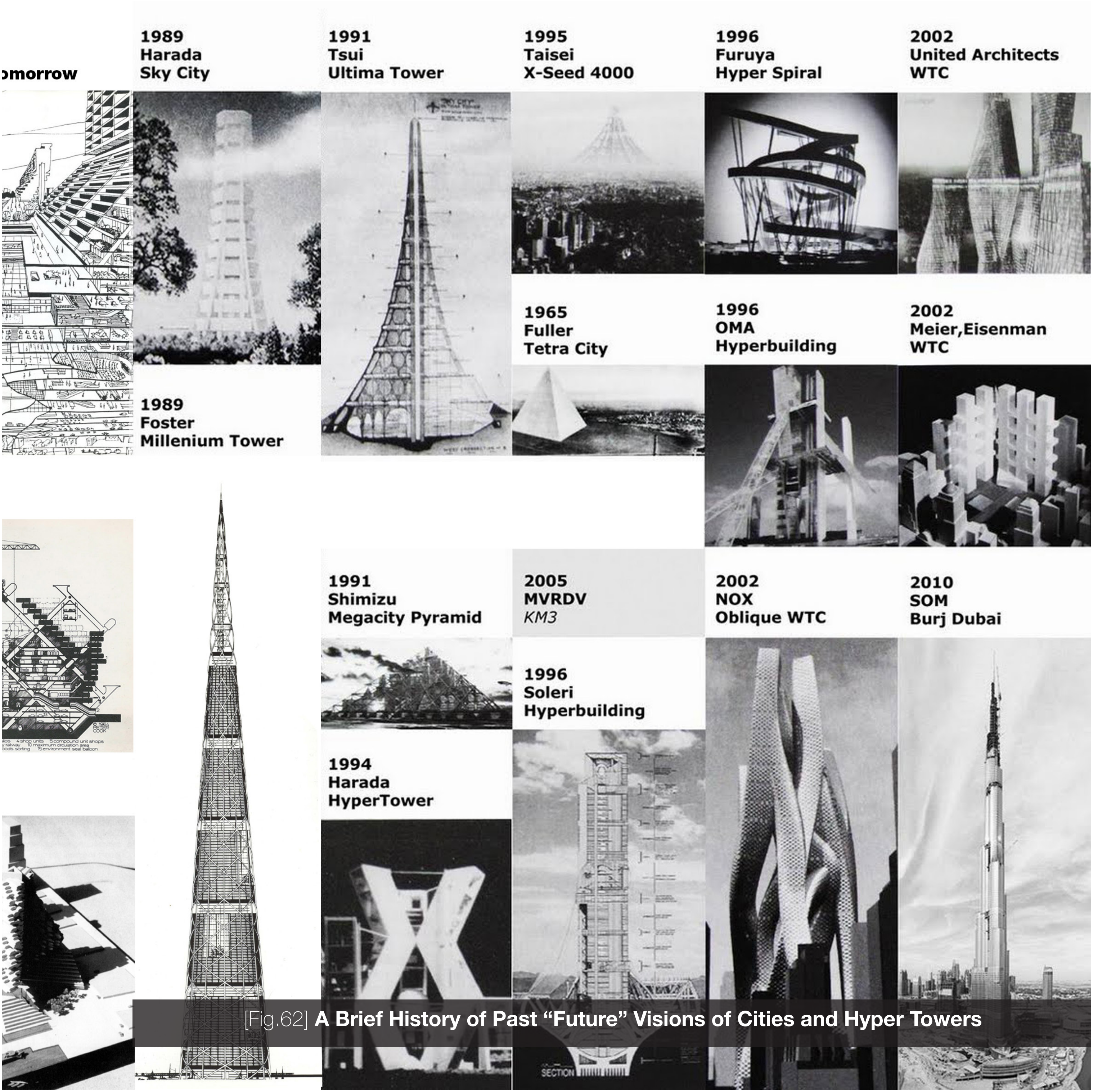


1964
Peter Cook
Plug-in City



1967
Moshe Safdie,
Habitat NY





[Fig.62] **A Brief History of Past "Future" Visions of Cities and Hyper Towers**

“The skyscrapers of twentieth-century American city were dramatic in their arrival and equally dramatic in their visual and spatial presence, changing the physical and social spaces of everyday life and giving to the city its visual signature-the skyline.”[63]

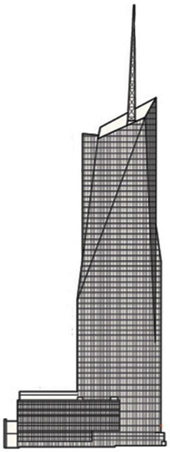
63 Moudry, 2005, 01.

“The skyscraper served as a quintessential metaphor for American modernity, […] It was an icon of industrial prowess, of technological innovation and advanced assembly methods, of the new, more dynamic, more prosperous world.“[64]

64 Mallgrave, 2005, 279.

new york city skyscrapers

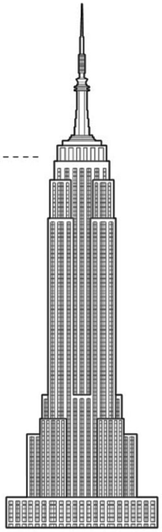
[Fig.63] **Location of New York City Skyscrapers,** including all buildings over 150m



Bank of America

In 2010, The Bank of America became the tallest building completed in New York since completion of World Trade Centre Two in 1973. (CTBUH Best Tall Building Americas Winner in 2010)

Completion date:	2009
Architectural height:	366m(1,200ft)
Stories:	55
Primary Use:	Office
Structural Material:	Composite



Empire State Building

The Empire State Building was the world's tallest buidling for long 41 years (1931-1972). It was replaced by New York's 1 World Trade Center. The Empire State Building is perhaps New York's most iconic skyscraper.

Completition date:	1931
Architectural height:	381m(1,250ft)
Stories:	102
Primary Use:	Office
Structural Material:	Steel

Eight Spruce Street

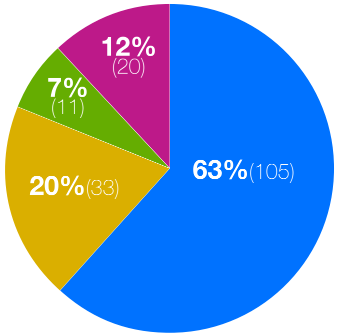
it is North America's tallest residential building, completed in 2011(CTBUH Best Tall Building Americas Winner in 2011)

Completition date:	2011
Architectural height:	265m(870ft)
Stories:	76
Primary Use:	Residential
Structural Material:	Concrete

168 buildings

76%

of NYC total



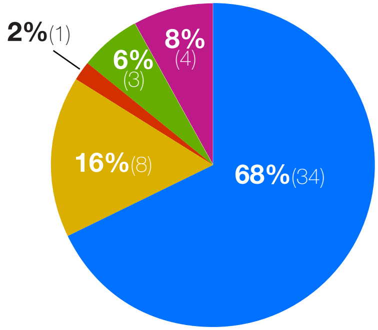
Function

[Fig.64] **Midtown District** 150m+ Buildings
(data CTBUH 2011)

50 buildings

23%

of NYC total



Function

[Fig.65] **Financial District** 150m+ Buildings
(data CTBUH 2011)

people decided to build a city with the tower "whose top may reach unto heaven"[65]. The Tower of Babel, as the story says, has not been finished, and often it is related to the great structures of that time, a Ziggurat dedicated to the Mesopotamian God Marduk by Nabopolassar, king of Babylonia (c. 610 BC). The base of the Great Ziggurat of Babylon was a square (not round), 91 meters in height, and demolished by Alexander the Great.

Unfortunately, the ancient time well-known structures are mostly ruined or completely destroyed by the natural disasters, like the Hanging Gardens of Babylon, Lighthouse of Alexandria and Mausoleum at Halicarnassus.

The Great Pyramid of Giza (146.5 m), built in the 26th century BCE, was once the tallest building built in the ancient times.

Those monuments may not look like the towers from our perspective, but they are proving to be one! All cultures worldwide, in the highest cultural and technological point of their existence, have tried to reach, for them the unreachable – the Sky. It could be that they have tried to get closer to the Sky, which also meant closer to God, or maybe to have a better overlook in the distance. Those buildings could also be a proof of dominance in front of the potential enemies. They always had a symbolic value, connoting the prestige, power, wealth of kings and nobles, but mostly they were built for spiritual, administrative or defensive needs.

Later in the 14th century, CE Lincoln Cathedral (Lincoln, England) has reached the height of 160 m and it was reputedly the tallest building in the world for 238 years (1311–1549), until it was blown down in a storm in 1548. The Washington Monument, white obelisk built in the 1884, has reached the height of (169 m), but none of these structures can be linked

65 NIV, 2000,10.

with the modern definition of a skyscraper, because they actually stayed uninhabited.

Until the 20th century and the era of the American Skyscrapers, tall buildings were built mostly for spiritual, administrative or defensive needs.

The most important factor in the early skyscraper development was innovation of the iron frame. The self-supporting iron frame was developed in England, in the first half of 19th Ct. After the 1850, the French engineer Gustave Eiffel, made a groundbreaking innovation of the riveted iron construction. In the 1885, further advanced iron structure reached the United States with Eiffel's design for the internal support structure for the Statue of Liberty. Gustav Eiffel's 300 m tower design for the 1889 World Exhibition in Paris, was a direct challenge to American engineers. The iron frame was rapidly replaced by rolled steel with development of the Bessemer process.

Second very important factor, was invention of a passenger mechanical elevator in the 1853 by Elisha Graves Otis, which prevented the fall of the cab if the cable broke. Safety and comfort in an upward travel became possible for people. On March 23, 1857, the first passenger elevator was installed into five-story office building 488 Broadway in New York City.

Despite the technological breakthrough in the 19th century, the first tall buildings in Chicago arose from necessity. "After the Great Chicago Fire of the 1871, developers and architects were faced with a daunting task: how to rebuild an entire city in a modern way using fire-resistant materials." [66] The fact that more and more people came to the cities to seek work and prosperity; new social and cultural attractions have required new typologies and developments in Chicago and New York. Large industrial and financial organizations needed new headquarters and office buildings located in city centers directly connected with transcontinental railway and water routes. By the beginning of the twentieth century, Chicago was one of the fastest growing cities in the world. Chicago's location, situated in the center of the North American continent, well connected with other states and Canada by rail and water channels, was major impact for the city's growth.

66 Ali/Armstrong 2010, 2.

The early high-rise buildings were supplemented by the “curtain wall” system, outer covering building system where the outside walls are not load bearing. The walls have been made of thin cut stone, glass, metal, or any other mass-produced material. After the Great Chicago Fire in the 1871, early tall buildings in Chicago were made of the cast iron and the steel frame covered with fire resistance material, such as stone or brick.

The central business distrcit was competely destryed in this catastrphe of 1871, and thousands and thousands of people were left without their homes. This led to a greater demand in the office space, and in years to follow, a major commercial real estate boom. Financial investors were insisting on a greater return on investment by urging the architects to build more floors and provide maximum space usage.

Chicago was laid out in a new urban grid pattern of large blocks based on the Thomas Jefferson survey from the early 19th century. Block buildings with large floor areas were required. Architects have configured the buildings around atria, or in H-, I-, E-, L- shapes to bring light and ventilation into the offices.

According to Lepik, the ten-story Home Insurance Building in Chicago (1885) was the first tall building addressing these economic and financial pressures as it was designed according to the new construction methods. The architect, William Le Baron Jenney, used the steel frame as a support to the masonry walls, instead of the common used iron constructions. This new construction exemplified a major step forward in building higher without increasing the thickness of the walls.

Chicago became a symbol of skyscraper development. In a three year time period, after the Home Insurance Building was constructed, a twenty-two floor and a 92m (302 feet) high Masonic Temple was built and it claimed the first publicly known title of the tallest building of that time, but by the 1895 it was overthrown by the Reliance Building whose large plate glass windows marked the dominant feature design in the 20th century.
While the major technological and structural breakthroughs favored taller building designs, the skyscraper’s height was not yet a notable characteristic, since the architectural theory and teaching at that time

was primarily focused on the traditional palace architecture and could not completely follow with the change in the structural design. Louis Sullivan developed a theory of tall and narrow skyscraper's look when rising high, as he recognized the concern of tall buildings overshadowing each other by being so closely together, and leaving offices and the street with no natural light. With his partner Dankmar Adler, he had built two important buildings for that time, the Wainwright Building in St. Louis (1891) and the Guaranty Building in Buffalo (1895). Although Sullivan made changes with the design of these buildings emphasizing the vertical running columns between the windows to extend in height, the overall style of the design was closed and solid failing to capture the benefits of the curtain wall system. Sullivan was also known for promoting the idea that tall buildings should be divided into three distinct sections: a base, a shaft and a capital.

The Race for the Tall[67]

With the completion of the 984 feet tall Eiffel Tower in 1869, the official race for reaching the greater heights and touching the skies had started. The Eiffel Tower did not count as a functional building, but it was still a very powerful image for the futurists and visionaries of that time, considering the fact that it was the tallest man-made structure in the world. The thirst was growing, not just between the architects and their potential investors, but also between the cities, all wanting to claim the power status and image.

After the completion of the American Surety Building in 1896, the New York City had claimed the title for the tallest building and became a leader in the skyscraper developments. The skyscrapers in New York City were tower-like structures, compared to the traditional block and rigid designs that were seen in other cities. The architects, inspired by the European models and architectural teachings, used certain exterior details for their own designs. For instance, the tip of the Singer Tower had details from the corner turrets of the Louvre Museum in Paris, the Metropolitan Life Insurance Tower from Campanile of San Marco in Venice, the top of the tower of the Bankers Trust Company Building was modeled as that of the Mausoleum of Halikarnass, whilst the Woolworth Building (1913) in New York City and the Chicago Tribune Tower (1925) replicated the neo-Gothic

67 Vgl. Lepik, 2004, 8.-17.

Cathedral style.

With its rapid growth in the Manhattan area, skyscrapers changed the image of the New York City, and the idea of a skyscraper skyline became another obsession for the architects of that time.

Although, no building regulations were passed until the 1916's Zoning Law, Ernest Flagg, the Singer Tower's architect, realized that such a trend would in turn cause urban problems because each higher skyscraper would overshadow the neighboring buildings and causing the property to devaluate, as well as the potential problems caused by the increased car traffic and fire ignition.

Skyscrapers were not just tall buildings for public to admire from the street level, but many had introduced the open terraces that engaged the people, like in the example of Singer Tower's 40th floor or the 55th floor of the Woolworth Building. The terrace or the viewing platform had provided an opportunity for people to connect with the skyline in a more spectacular way.

Apart from the improvements in elevators and lighting systems, the specific changes to the exterior looks of the skyscrapers did not emerge with modernism in the United States. Walter Gropius, the German architect and one of the pioneers of the modern architecture, after traveling through the States had famously said, "There is no true American architecture yet."[68]

This held true, because the European developments and models had largely influenced the rising modernist skyscrapers in the States. American architect, Raymond Hood, who won the competition for designing the Chicago Tribune Tower, was inspired by the neo-Gothic architecture for this design, but soon after, with his Radiator Building in New York contributed to spreading of the Art Deco building style, which incorporated craft motifs and machine age imagery and materials.
The important step forward in the further development of the skyscrapers was the completion of the Chrysler Building (1930) and the Empire State Building (1931). The Chrysler Building was the first building to overtake the height of the Eiffel Tower, but soon was overthrown by the Empire State

68 Gropius,1928 zit.n. Lepik, 2004, 12.

Building. The architects followed Sullivan's idea of a three-section unit and paid closer attention to the typology of tall buildings specific to the New York City area.

The Empire State Building provided many insights for the architects; firstly, its height was unchallenged for forty years, its docking mast for zeppelins proved that the skyscrapers can be accessed directly from the sky, the viewing from the open terrace was providing return on investment in the hard time of the Great Depression, and the steel frame construction saw its end because to build higher with this method was to expensive.

With the completion of the Rockefeller Center, the new concept of "city within a city" had been discovered. The vision was to have tightly grouped skyscrapers that contained open areas and roof gardens, plazas and concert halls, thus becoming more functional structure. It was the first mix of functions and the careful integration of the skyscraper into their urban surrounding.

Amongst many other well-known European architects who took refuge to the States due to the wartime in Europe, Ludwig Mies van der Rohe became an important figure in further development of tall building designs. He promoted a dynamic design, the concept used in the design of the World Trade Center and the Vienna Twin Towers. Mies also constructed Seagram Building and Lever House, whose quality in the architectural terms would be hardly ever matched. These buildings became the reference point for the skyscraper's architectural style in the United States, being closely connected with their urban setting from the street level and providing the introduction to the public plaza, a new gathering point for the public.

The end of the Second World War saw the beginning of the skyscraper developments in Europe. The difference between American and an early European styles of building skyscrapers could be seen in the examples of the Torre Pirelli in Milan and Thyssenhaus in Dusserldorf, where the concrete construction was used providing the building with an elegant and dynamic look. The European building regulations were stricter giving the European tower blocks a very narrow look.

The race for the tallest building in the world faded away around the 1960s with the average height of the skyscrapers reaching fifty to sixty floors. Harry Seidler sparked new excitements when designing Australia Square skyscraper in Sydney, which was based on the rounded plan and advantageous structural stability that could answer the problems with winds blowing against it. This structure opened the gates for the upcoming developments of the amazing skyline in the Sydney area.

A new step ahead in the evolution of skyscrapers was achieved with the completion of Chicago's John Hancock Center in 1969, where Fazlur Khan introduced the tubular design and made building tall more efficient and resistant to wind and seismic forces, and importantly undependable on expensive traditional steel frame. Khan designed the Sears Tower using the bundled tube, the concept that completely revolutionized the skyscraper design, helping the structures to take on different shapes. Sears Tower reigned twenty-two years as the tallest building of all times with such a design.

While the constructions were getting taller and taller, their exterior design failed to produce a deeper attachment with the public. The architects did not yet understand how to connect their designs with the urban surroundings, leaving the structures to be regarded as rigid monuments with poor aesthetics. This changed with the construction of the Transamerica Pyramid in San Francisco, which embodied the eloquent form.

With the arrival of the 1970s, the market for skyscraper development had become global. The skyscrapers were carrying the image of the nations' economic status and power, so many countries employed architects for projects from all over the world urging to claim the success. The National Commercial Bank in Jeddah, designed by Gordon Bunshaft, was such a distinctive and remarkable high-rise structure with the breathtaking views of Jeddah city center and the Red Sea.

Post Modernism[69]

The AT&T Headquarters Building, designed by Philip Johnson in 1984, marked the arrival of the postmodern era. Postmodernism applied the comeback of the historicism and symbolic detail in the skyscraper design. The glass curtain wall had been replaced with the heavy stone façade and the Sullivan's three-part structure. The pyramid-shaped peak was decorating many skyscraper projects completely failing to connect with the urban setting. Such examples were DG Bank Hochhaus in Frankfurt/Main and the First Bank Place in Minneapolis.

With the failures of postmodernistic movement, new architectural approaches came to life, which included modernistic concepts, thus the spotlight was turned back on architectural construction methods and technology. The Centre Pompidou (1978), designed by Richard Rogers and Renzo Piano, a modern looking and colorful structure, was placed purposely within the highly recognized historic surrounding in Paris. Norman Foster's Hong Kong and Shanghai Bank were realized in Asia in the mid-1980s, and these skyscrapers demonstrated expressive aesthetic and a greater space in the interior, while the I.M.Pei's Bank of China took on a different turn by incorporating the diagonal spatial trusses making the exterior of the building into a rigid tube. In Japan, the New Tokyo City Hall was yet another contrasting approach by using the twin-tower motif from the history of European architecture.

69 Vgl. Lepik, 2012, 17.-19.

Ecological Breakthrough[70]

Even though, high-rise buildings are not considered as ecological, they do represent an efficient solution for the overly populated cities. Norman Foster, in his Hong Kong and Shanghai Bank projects discovered ways to reduce natural water consumption by substituting it with the seawater, which he used for building cooling purposes and flushing of the toilets. By designing Menara Mesiniaga in 1992, Ken Yeang, a green skyscraper pioneer, demonstrated ecologically practical tall building that twists allowing natural light to cover all the workstations of the building, therefore reducing the energy consumption and relying on natural lighting.

Constantly Racing

The new race for the millennium included countries that were all aspiring the title of the tallest building in the world, but perhaps overexcitement had led to many projects not being realized due to financial restrictions. Examples included Cesar Pelli's Miglin-Beitler Tower (2,000 feet), Norman Foster's Millennium Tower for Tokyo (2,754 feet) and Millennium Tower for London (1,265 feet), Jean Nouvel's Tour Sans Fin in Paris, Harry Seidler's tower for Melbourne (1,625 feet), the Bionic Tower (4,029 feet) from Javier Pioz and the group of Spanish architects, the Green Bird tower in London (1,450 feet) planned by Future System team of architects, and a 2,000 feet tall SOM's 7 South Dearborn in Chicago. Towards the end of the millennium, the Asian' Petronas Towers won the title for the tallest skyscraper in the world. To reach these incredible heights, like that of the Petronas Towers (1,483 feet) and the Jin Mao Tower (1,380 feet), the architects utilized megasupports, a new construction method based on cylindrical tube frame system made up from a strong and rigid concrete core.

The 2004 saw yet another great architectural accomplishment, with the construction of Taipei 101 (1,667 feet), which was the tallest building in the world for six years.

70 Vgl. Lepik, 2012,19.-22.

[Fig.66] **The New Aspects Of Tower Design,** 30 St Mary Axe, London by Norman Foster (2004)

New Typologies[71]

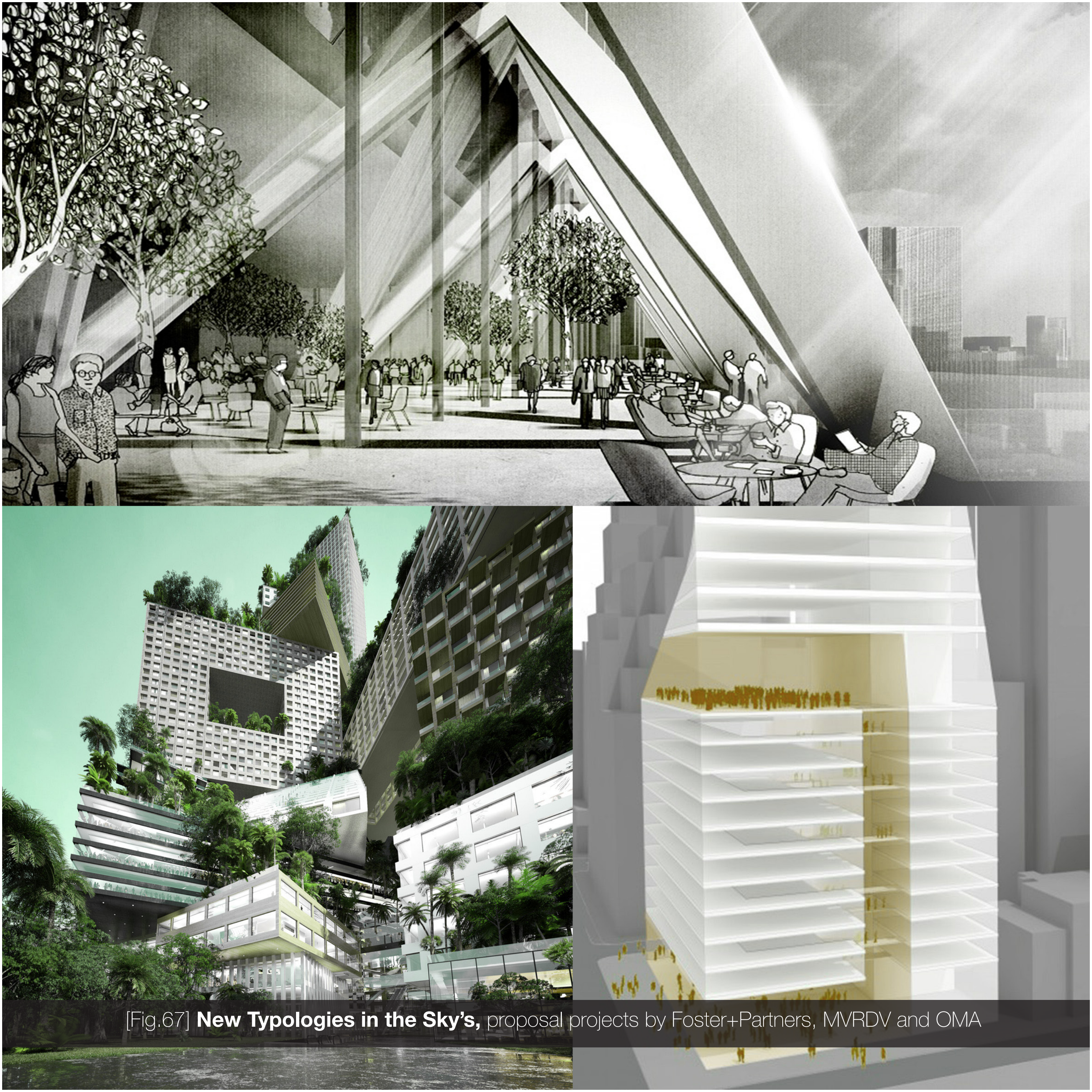
A big driver for the evolution of skyscrapers, from its early stages, was commercial interest. The status for a company, client, city or a country, that a skyscraper would signify was of a higher importance, more so than its slow return on investment. Reaching ever-greater heights and designing a quality looking structure was both equally important in the public eye.

Renzo Piano's London Bridge Tower was an exciting project in 2009, as it incorporated public spaces or "piazzas in the sky," a notable characteristic of the future skyscraper designs.

Rem Koolhass, a Dutch architect, idealized 'skyscraper city' with many different structures and it was yet another example of finding different typology, as well as the Ground Zero project by the United Architects, which focused on vertical interconnected urban structure.

Skyscrapers may have emerged in the USA, but with its rapid evolution they became a unique symbol of power status globally. Even though the skyscraper structure became known as a signature building of many nations and cities, the potential for greater advancements is still awaited. New typologies might signal the way ahead for the development of even greater skyscrapers, which will continue to provoke attention and amazement.

71 Vgl. Lepik, 2012, 23.-25.



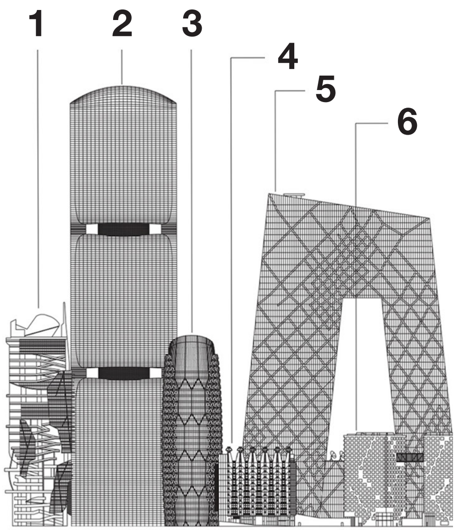
[Fig.67] **New Typologies in the Sky's,** proposal projects by Foster+Partners, MVRDV and OMA

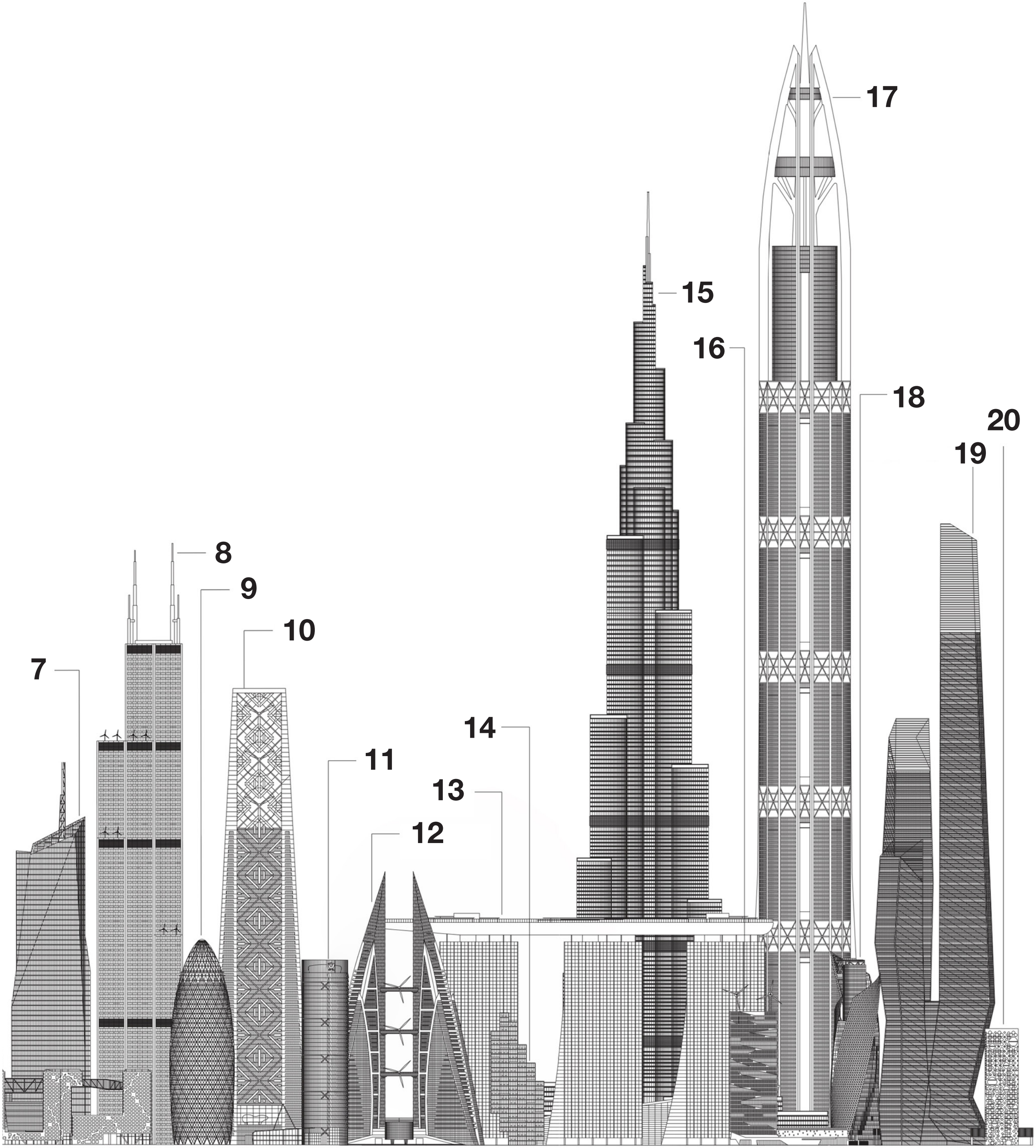
20_INNOVATIVE

The 21st century has already seen some of the leading edge projects in the high-rise structures that earnestly challenge the traditional methods of skyscraper design and construction, whether in its form, function, height, planning, skin or operation. CTBUH produced a study that identifies "Innovative 20" buildings either completed or in its process, that clearly demonstrate advanced and alternative approaches to building tall. New kind of design and shape to answer the urban problems, solution to ecological issues, or simply a creative visual expression of a building, had pointed out that the future of skyscrapers is pronounced both in innovation and imagination.[72]

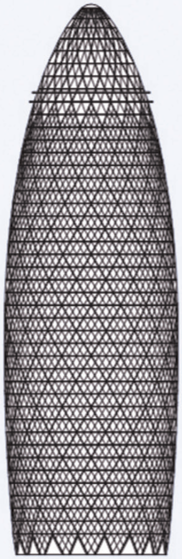
72 CTBUH, 2010, 2.

1.EDIT Tower (intended)	2015
2.Pearl River Tower	2011
3.Abu Dhabi Investment Council Headquarters	2012
4.Council House 2	2006
5.CCTV Headquarters	2010
6.Linked Hybrid Building	2009
7.Bank of America	2009
8.Willis Tower Retrofit	2014
9.30 St Mary Axe	2004
10. The Light House	2012
11. Post Tower	2003
12. Bahrain World Trade Center	2008
13. Marina Bay Sands Integrated Resort	2010
14.Rødovre Skyvillage (intended)	2015
15. Burj Khalifa	2010
16. La Tour Vivante	2006
17. Nakheel Tower (intended)	2020
18. Mode Gakuen Spital Tower	2009
19. World Business Center Solomon Tower (intended)	2013
20.O14	2010





[Fig.68] **Innovative Tall Building design,** approach for 21st century (CTBUH 2010)



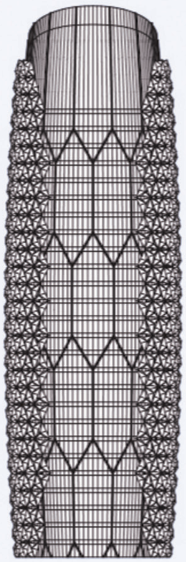
30 St Mary Axe
London, UK

Innovation

One of the first skyscrapers to adopt an amorphous form, whilst employing innovative structural (diagrid) and environmental strategies

Height
180m/590ft
Completion
2004
Building Use
Office

Structural Material
Steel
Total Floors
41
Owner/Developer
Swiss Re
Architect
Foster + Partners
Structural Engineer
Arup
MEP Engineer
Hilson Moran Partnership Ltd



Abu Dhabi Investment Council Headquarters
Abu Dhabi, UAE

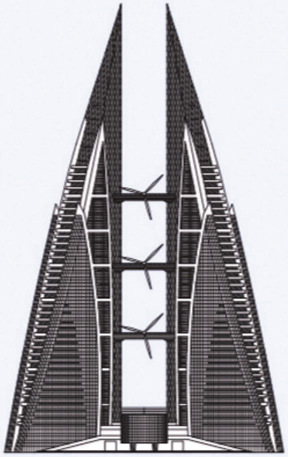
Innovation

Innovating in the use of a dynamic, responsive façade, opening and closing in response to the sun's path

Height
145m/476ft
Completion
2012
Building Use
Office

Structural Material
Composite
Total Floors
29
Owner/Developer
Abu Dhabi Investment Council
Architect
Aedas
Structural Engineer
Arup
MEP Engineer
Arup

Bahrain World Trade Center
Manama, Bahrain

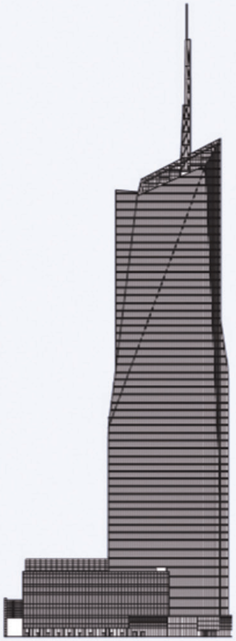


Innovation
The first large-scale integration of wind turbines in a building, generating approximately 11–15% of the building's electrical energy requirements

Height
240m/787ft
Completion
2008
Building Use
Office

Structural Material
Steel/Concrete
Total Floors
45
Architect
WS Atkins & Partners
Structural Engineer
WS Atkins & Partners
Contractor
Nass, Murray & Roberts (JV)

Bank of America Tower
New York, USA



Innovation
The first tall building designed to attain the US Green Building Council's LEED Platinum certification

Height
365m/1198ft
Completion
2009
Building Use
Office

Structural Material
Steel
Total Floors
54
Owner/Developer
Bank of America/Durst Organization
Architect
Cook + Fox Architects
Structural Engineer
Severud Associates
MEP Engineer
Jaros, Baum & Bolles
Contractor
Tishman Construction Corporation

[Fig.69] **_20 Innovative Tall Building projects,** (data CTBUH 2010)

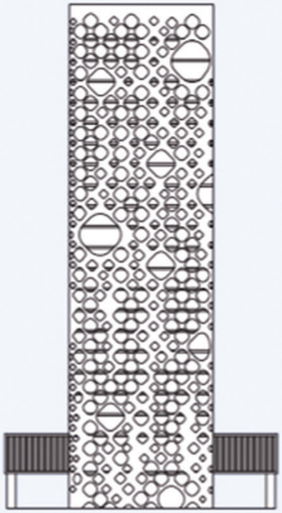
Mode Gakuen Spiral Towers
Nagoya, Japan

Innovation

Innovating in both form and program; one of the first significantly twisting towers, accommodating educational facilities to form a high-rise school

Height
170m/558ft
Completion
2009
Building Use
Educational

Structural Material
Steel
Total Floors
36
Owner/Developer
Mode Gakuen
Architect
Nikken Sekkei Ltd
Structural Engineer
Nikken Sekkei Ltd
MEP Engineer
Nikken Sekkei Ltd
Contractor
Obayashi Corporation



O14
Dubai, UAE

Innovation

Innovative envelope, with the use of a perforated concrete shell acting as primary structure and reducing solar exposure and promoting building cooling

Height
102m/334ft
Completion
2010
Building Use
Office

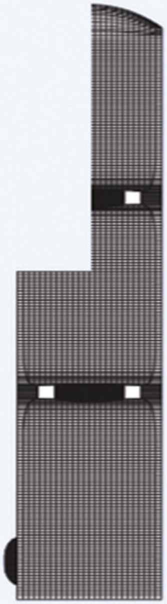
Structural Material
Concrete
Total Floors
21
Owner/Developer
AlBaraka Islamic Bank; Creek Side Development Company
Architect
Reiser + Umemoto
Structural Engineer
Ysrael A. Seinuk
MEP Engineer
Al Bonian International
Contractor
Dubai Contracting Company LLC

Nakheel Tower
Dubai, UAE

Innovation
The world's first kilometer-high tower to start construction on site

Height
1000m+/3280ft+
Completion
2020 (Intended)
Building Use
Office/Hotel/Residential

Structural Material
Steel/Concrete
Total Floors
200+
Owner/Developer
Nakheel
Architect
Woods Bagot
Structural Engineer
WSP Group; Leslie E. Robertson Associates RLLP; VDM Group
MEP Engineer
Norman Disney & Young



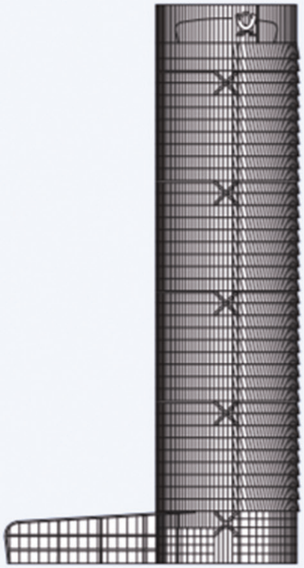
Pearl River Tower
Guangzhou, China

Innovation
Designed for carbon neutral operation, through use of a high-performance envelope, integrated wind turbines, photo-voltaics and other features

Height
310m/1016ft
Completion
2011
Building Use
Office

Structural Material
Composite
Total Floors
71
Owner/Developer
Chinese National Tobacco Company
Architect
Skidmore Owings & Merrill LLP
Structural Engineer
Skidmore Owings & Merrill LLP
MEP Engineer
Skidmore Owings & Merrill LLP

[Fig.70] **_20 Innovative Tall Building projects,** (data CTBUH 2010)



Post Turm
Bonn, Germany

Innovation
One of the first towers to employ a double-skin façade in the quest for full natural ventilation, eliminating a centralized mechanical air-conditioning plant

Height
162m/533ft
Completion
2003
Building Use
Office

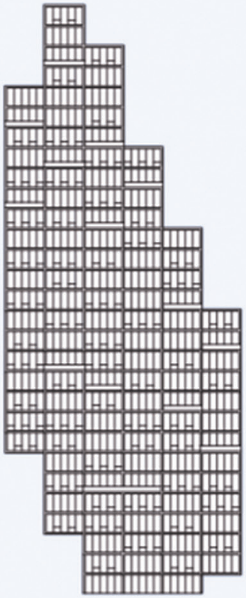
Structural Material
Composite
Total Floors
42
Owner/Developer
Deutsche Post AG
Architect
Murphy/Jahn Architects
Structural Engineer
Werner Sobek Ingenieure GmbH
MEP Engineer
Transsolar ClimateEngineering; Brandi Consult GmbH

World Business Center Solomon Tower
Busan, South Korea

Innovation
A radical experiment in form, with three tapered towers rising from a single base

Height
433m/1419ft
Completion
2015 (Intended)
Building Use
Office

Structural Material
Composite
Total Floors
108
Owner/Developer
Nakheel
Architect
Solomon Group
Structural Engineer
Arup
MEP Engineer
Arup



Rødovre Skyvillage
Copenhagen, Denmark

Innovation

Innovative in both form and internal planning, with internal space organized so as to create maximum flexibility for future adaptation

Height
116m/381ft
Completion
2015 (Intended)
Building Use
Office/Residential/Hotel

Structural Material
Steel
Total Floors
29
Owner/Developer
Brainstones Aps
Architect
MVRDV; ADEPT
Structural Engineer
Søren Jensen Rådgivende Ingeniørfirma; ABT

Willis Tower Retrofit
Chicago, USA

Innovation

40 Years after its completion, the planned green retrofit of this seminal building shows the way forward for the upgrade of existing skyscrapers

Height
442m/1451ft
Completion
2014
Building Use
Office

Structural Material
Steel
Total Floors
108
Architect
Adrian Smith + Gordon Gill Architecture

[Fig.71] **_20 Innovative Tall Building projects,** (data CTBUH 2010)

Burj Khalifa
Dubai, UAE

Innovation

The first building to surpass 600, 700 and 800 meter height thresholds, and exceed the previous world's tallest building by over 60% in height

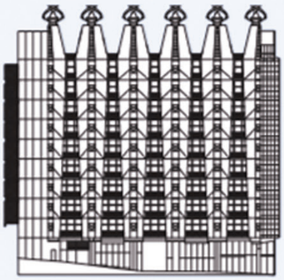
Height
828m/2717ft
Completion
2010
Building Use
Office/Residential/Hotel

Structural Material
Seel/Concrete
Total Floors
163
Owner/Developer
Emaar Properties
Architect
Skidmore Owings & Merrill LLP
Structural Engineer
Skidmore Owings & Merrill LLP
MEP Engineer
Skidmore Owings & Merrill LLP
Contractor
Samsung Engineering and Construction; Arabtec; Besix

Council House 2
Melbourne, Australia

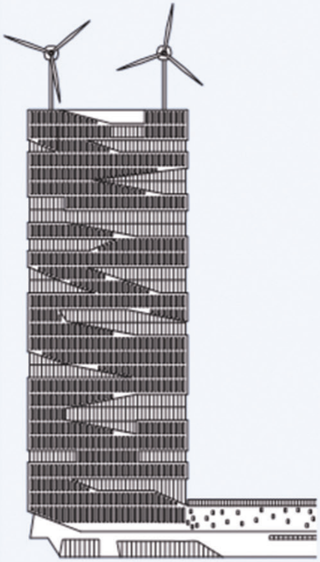
Innovation

Not particularly tall, but innovating radically in energy consumption – Australia's first new 6 star Green Star-rated commercial office building



Height
40m/131ft
Completion
2006
Building Use
Office

Structural Material
Concrete
Total Floors
10
Owner/Developer
City of Melbourne
Architect
DesignInc Pty. Ltd
Structural Engineer
Bonacci Group
MEP Engineer
Lincolne Scott; Advanced Environmental Concepts; A G Coombs
Contractor
Hansen Yuncken



La Tour Vivante
Rennes, France

Innovation
Proposing the cultivation of agriculture in cities, through the creation of "vertical farms," providing food at point of need

Height
140m/459ft
Completion
2015 (Intended)
Building Use
Residential/Office/Agriculture

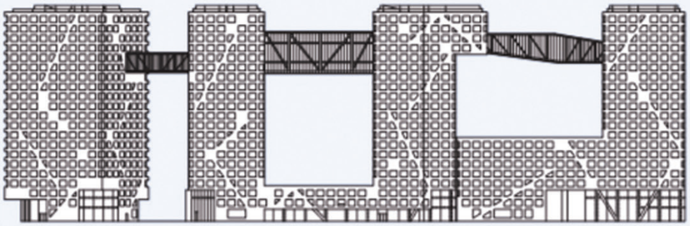
Structural Material
Concrete
Total Floors
30
Architect
SOA Architects
Structural Engineer
SETEC
MEP Engineer
SETEC

Linked Hybrid Building
Beijing, China

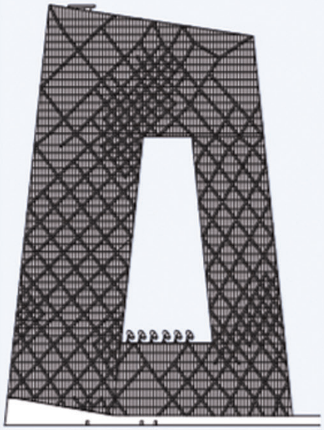
Innovation
A precursor to future "cities in the sky?" Contains a wide mix of functions in nine towers linked by skybridges

Height
66m/217ft
Completion
2009
Building Use
Residential, Hotel, Public space
Structural Material
Concrete
Total Floors
21

Owner/Developer
Modern Green Development Co., Ltd.
Architect
Steven Holl Architects; Beijing Capital Engineering Architecture Design Co., Ltd.
Structural Engineer
Guy Nordenson and Associates; China Academy of Building Research
MEP Engineer
Transsolar ClimateEngineering; Beijing Capital Engineering Architecture Design Co., Ltd.; Cosentini Associates
Contractor
Beijing Construction Engineering Group



[Fig.72] **_20 Innovative Tall Building projects,** (data CTBUH 2010)



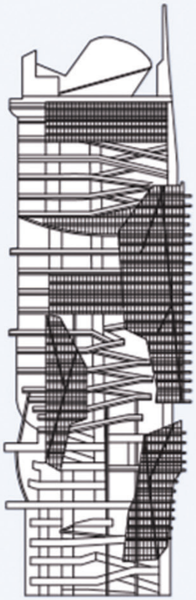
CCTV Headquarters
Beijing, China

Innovation

Challenges the form of the skyscraper, with a unique vertical and horizontal "looped" building and innovative structural and constructional approaches

Height
234m/769ft
Completion
2010
Building Use
Office

Structural Material
Steel
Total Floors
49
Owner/Developer
China Central Television
Architect
Office for Metropolitan Architecture
Structural Engineer
Arup
MEP Engineer
Arup
Contractor
China State Construction



EDITT Tower
Singapore

Innovation

Bringing organic matter into the urban realm, with continual vertical "eco-corridors" allowing migration of plant species and facilitating ambient cooling

Height
150m/492ft (est)
Completion
2015 (Intended)
Building Use
Exhibition/Retail

Structural Material
Concrete
Total Floors
26
Owner/Developer
National University of Singapore; Urban Redevelopment Authority, Singapore;
Architect
T. R. Hamzah & Yeang
Structural Engineer
Battle McCarthy
MEP Engineer
Battle McCarthy

The Lighthouse
Dubai, UAE

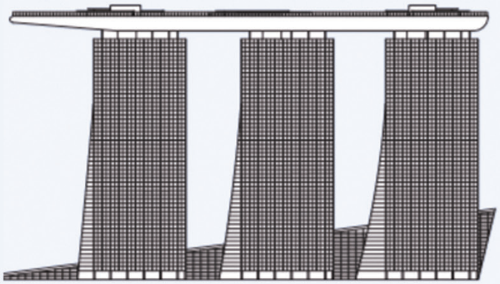
Innovation
Challenging pre-conceptions of Middle-Eastern high-rise by aiming to reduce energy consumption and water usage by 65% and 35% respectively

Height
402m/1319ft
Completion
2012
Building Use
Office

Structural Material
Composite
Total Floors
64
Architect
WS Atkins & Partners
Structural Engineer
WS Atkins & Partners

Marina Bay Sands Integrated Resort
Singapore

Innovation
The first significant towers to be joined at roof level, with the creation of a one hectare "skypark," positioned almost 200 meters in the sky



Height
203m/666ft
Completion
2010
Building Use
Hotel

Structural Material
Concrete
Total Floors
57
Owner/Developer
Marina Bay Sands Pte Ltd
Architect
Moshe Safdie and Associates; Aedas
Structural Engineer
Arup
MEP Engineer
Parsons Brinckerhoff Pte Ltd; Norman Disney & Young
Contractor
Ssangyong Engineering & Construction

[Fig.73] **_20 Innovative Tall Building projects,** (data CTBUH 2010)

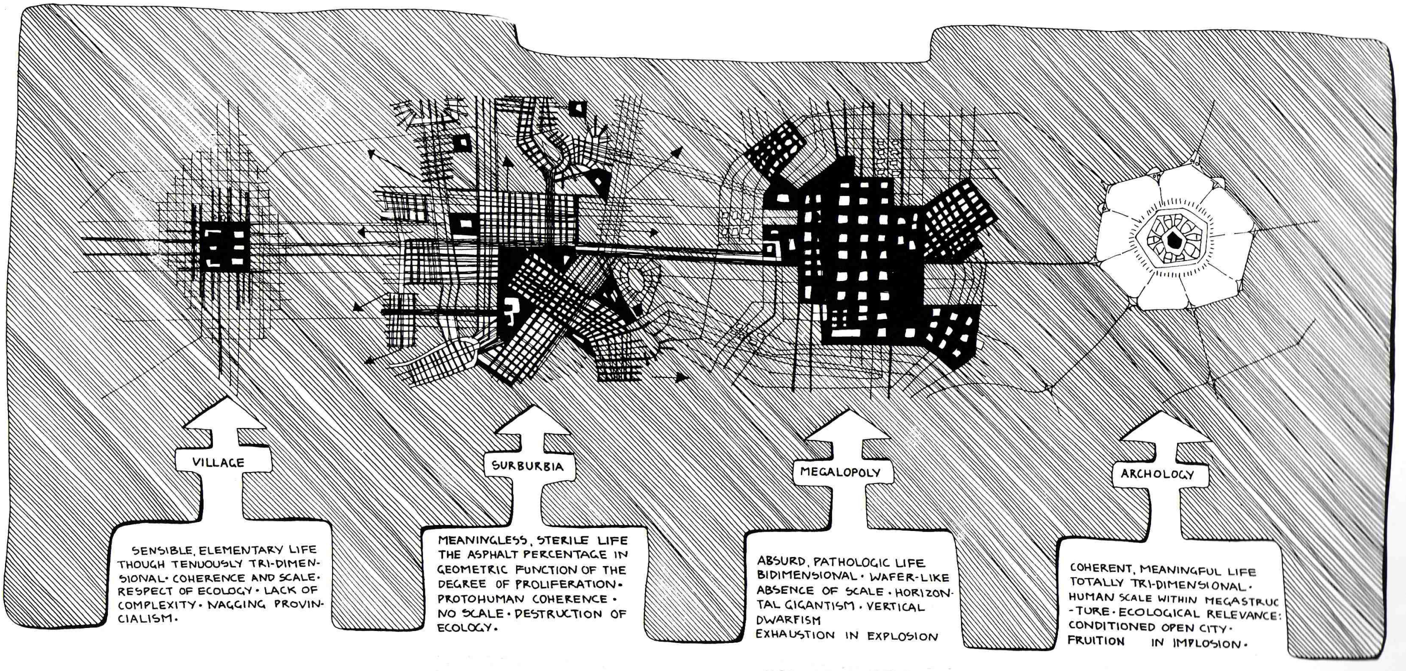
_urban arcology

Urban Arcology is a concept for cities that embrace fusion of architecture and ecology. Architecture design should be highly compact urban form, designed for enormous habitats (hyper-structure) or high-density population. It contains variety of functions inside one hyper structure, such as residential, commercial and agricultural facilities. It is opposite of the urban sprawl, and has been seen as self-contained and economically self-sufficient. The architect Paolo Soleri introduced the concept, but at this point, this concept is still of utopian nature.

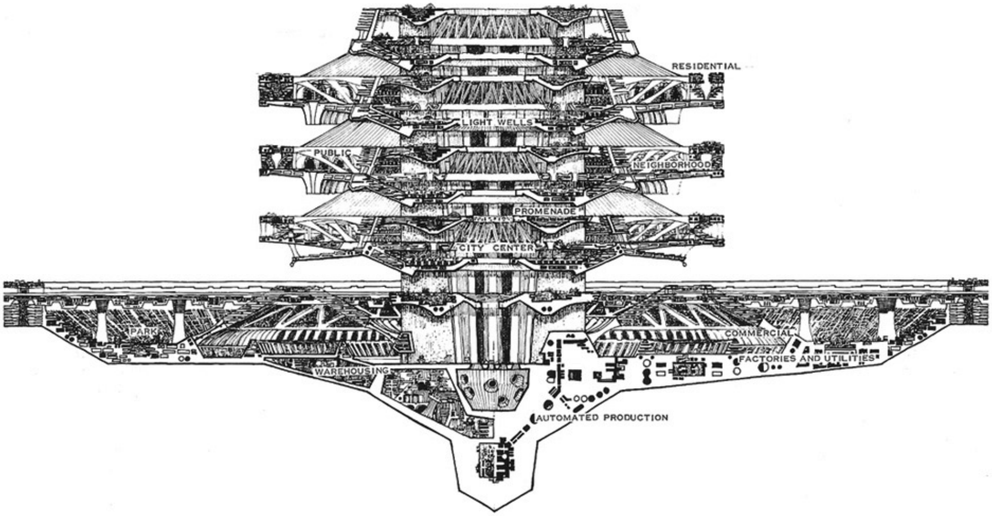
Arcology provides multi-use program in one megastructure, with public spaces and close-by working and living areas. It is based on sustainable methods for maintenance, power, climate control, air and water purification, waste treatment and food production. Passive techniques are introduced in order to reduce energy usage for lighting, heating, cooling and vertical transportation. The idea is to have agriculture located within the community. The aim is to offer efficient alternative for high-energy consumption, and to introduce energy efficient, sustainable, environmental friendly method of building and city design. This concept reduces dependence on car transportation.[73]

In order to keep this design realistic, my skyscraper design will use just few aspects of arcology, such as multi-usage, green and public open spaces, and sustainable passive techniques for high-density living.

73 http://www.superskyscrapers.com/, 2012



[Fig.74] **Diagram of Evolution of Village to Arcology**



[Fig.75] **Example of Arcology,** Soleri's Babel City

_redefinition of needs

VERTICAL THEORY BY KEN YEANG

During the last few decades, the approach to skyscraper design has changed. The crucial change was redefinition of needs. According to Yeang, we need more habitable working and living urban environments that are more diverse, with networks of plazas, parks and open spaces in the air. The Asian cities represent the densest areas of the world. The urban network, comparing to the USA and Europe, is narrow and restricted in terms of free space. That is the reason why the urban fabric in Asian cities is different than the one in the Western world. In those conditions, it is not enough to multiply stories and to make stacked trays piled homogeneously and vertically one on top of the other, but to provide within skyscrapers a multiplicity of land uses and a greater connectivity. The proposition of the skyscraper is not just an architectural design for a building type, but rather the urban design proposition where the skyscraper is a vertical extension of the city that carries out more complex and inclusive terms.

Skyscrapers need to be similar to successful urban spaces of many cities, with “external, internal and transitional spaces,” under the consideration of different needs for current and future users.

The future design of skyscrapers involves an integration of many other disciplines, and approach that includes ecology, economics, sociology, technology, psychology, environment, cultural theory, real estate, and etc.

[Fig.76] **Series of stacked newspapers represent most skyscrapers today,** repeating floors and functions

[Fig.77] **The variety of spatial delicacies at each level** – skyscrapers should be design as a series of vertical events

The objectives of urban design applied to the skyscraper design:[74]

-design and create a place with its own character and identity;

-ensure an urban continuity and enclosure in providing a place where public and private spaces are clearly distinguished;

-provide quality public realms as places with attractive, successful and accessible outdoor areas;

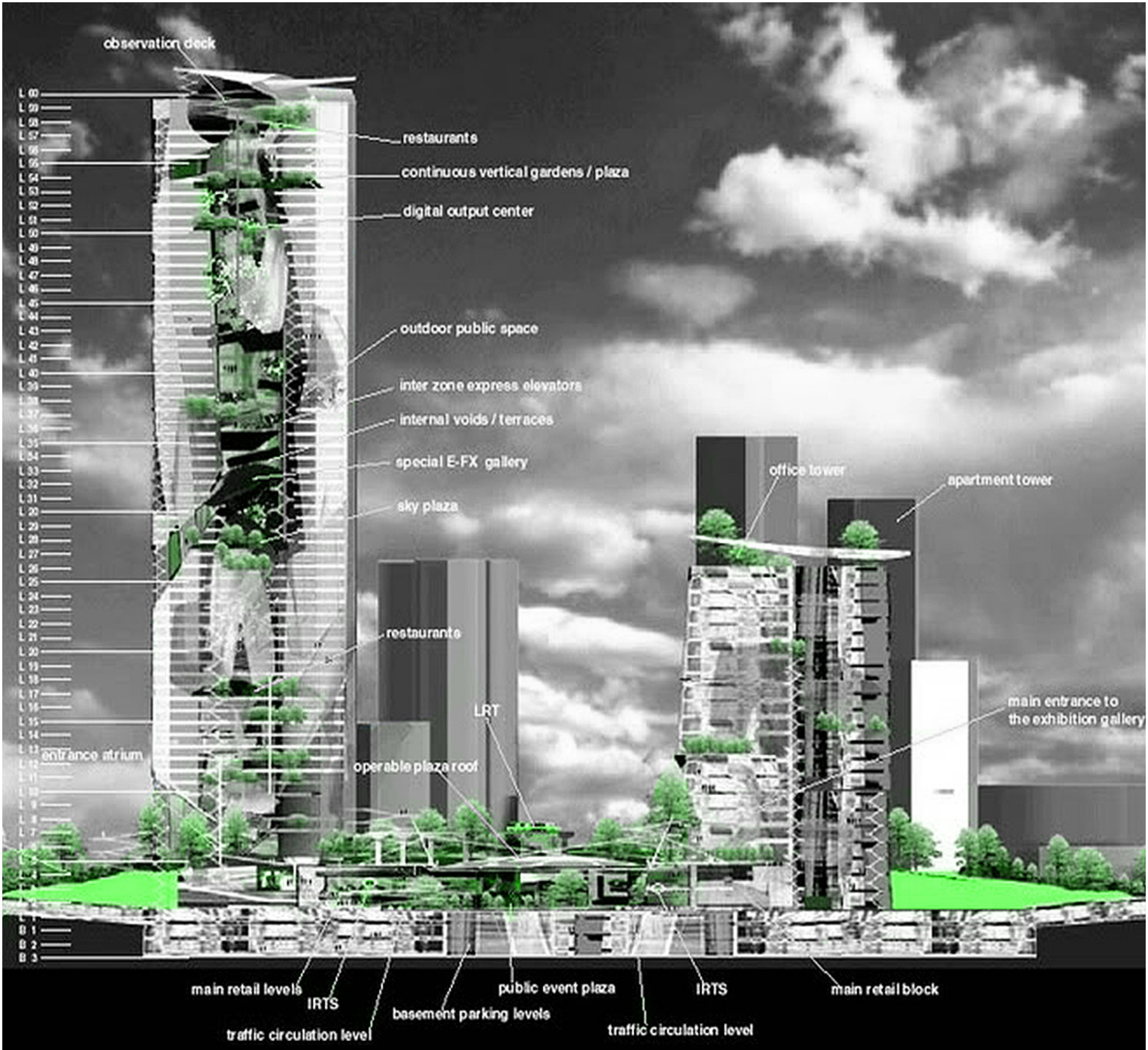
-provide ease of movement by creating places that are easy to get to and move through;

-design for legibility so that places are easy to understand and have a clear image;

-design for adaptability as places can change easily;

-provide diversity by crating places with variety and choice.

74 Yeang, 2002, 15.



[Fig.78] **Sustainable Tower,** by Ken Yeang

c**2**c_concept

In the book "Cradle to Cradle: Remaking the Way We Make Things" authors McDonough and Braungart indicated some of the issues they found in manufacturing processes, specifically the enormous usage of non-verified chemicals and the production of toxic waste, which pollutes the environment and harms people.

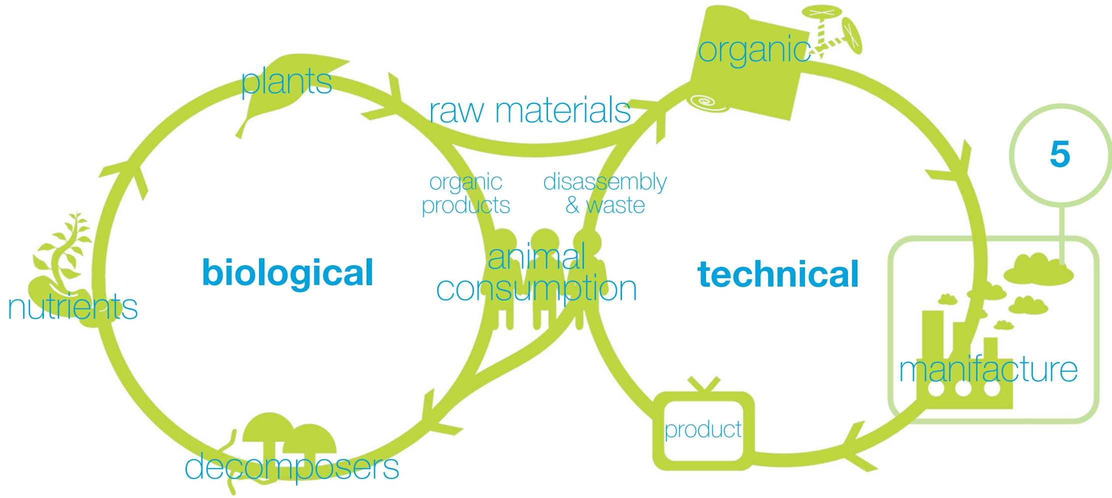
Authors pointed out that "eco-effectiveness" is a better solution, instead of today's "eco-efficiency" practice that proposes doing more with less. McDonough and Braungart describe today's production processes as linear, "cradle to grave," conceivably made with good intentions but still resulting with an enormous creation of waste.

Authors are insisting on products that are designed to be completely recycled. The most common process of recycling nowadays is downcycling (the process of converting waste into products of lower quality). "Eco-effectiveness" should be the form of endless cycle, where materials will be completely renewed with "no waste" policy, like the natural processes.

McDonough and Braungart suggested chemical classification of the materials that fabricate the product, where biological nutrients and particularly hazardous materials (technical nutrients) should be divided, in order to re-use those materials separately. The materials should be ranked with green (low risk), yellow (acceptable risk), red (high risk, slowly get rid of in process) and grey (incomplete data) color. This C2C idea should be implemented in many other disciplines of our civilization (architecture, economics and social systems), and not only in industrial production and design. One of those examples, as mentioned by the authors, is the Ford Motors River Rouge factory.

Imaginably, in this moment, the whole process of Cradle to Cradle design looks like utopia, but slowly the society is accepting this model.[75]

75 Vgl. Zheng, 2012



1.100% **Renewable Energy Use**
2. Water Stewardship clean water output
3. Social Responsibility positive impact on community
4. Material Reutilization recyclability/compostability
5. Material Health impact on human & environmental

CRADLE TO CRADLE CONCEPT

[Fig.79] **Cradle to cradle design,** biological and technical cycle

_by **2050**

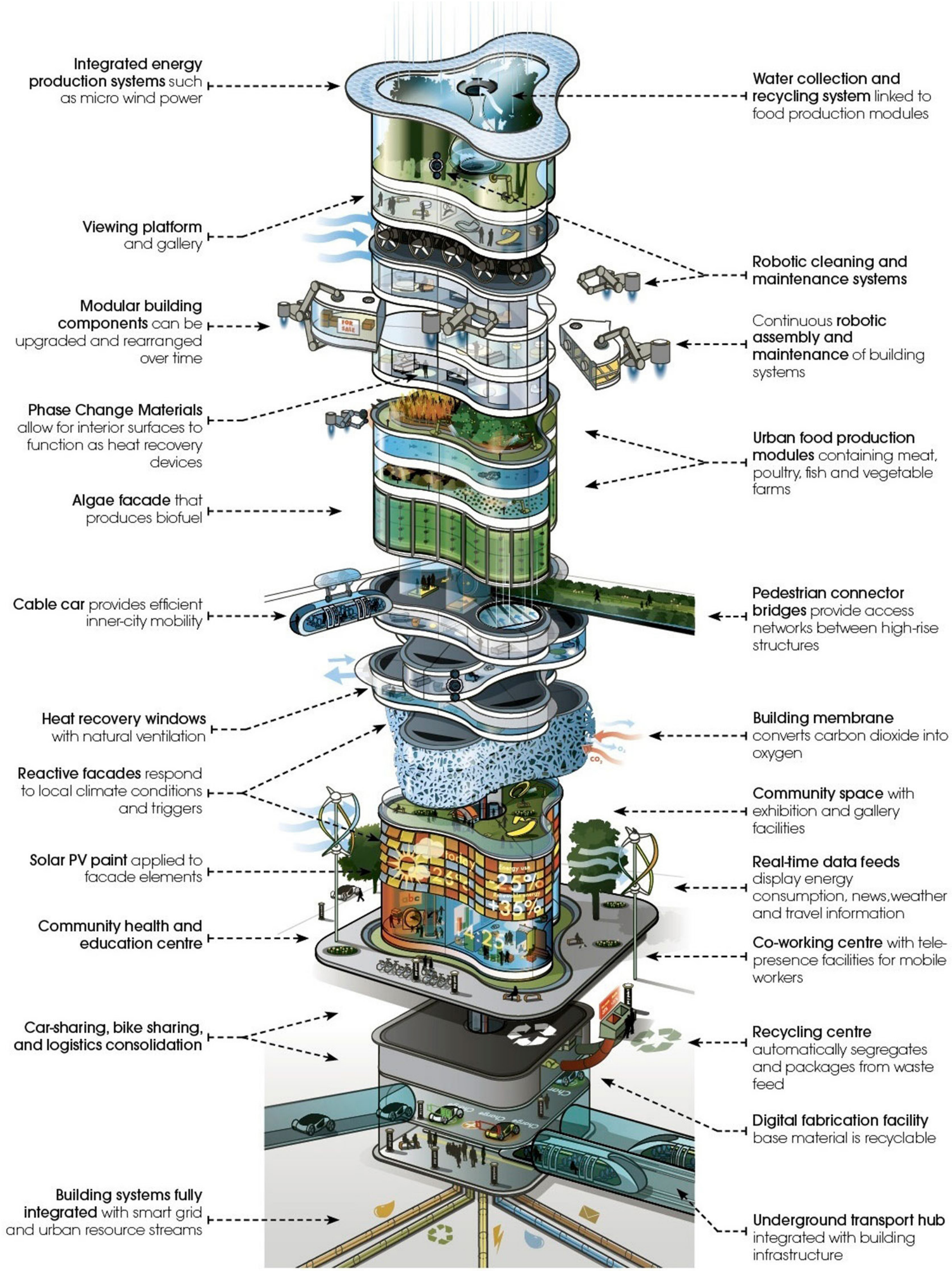
Through the development of hi-tech and usage of new communication methods, interaction between humans and their environment is constantly changing. Day by day, smart devices, systems and materials are developing. In the future, this process will be delivered on the next level, and it will be realistic to expect a new way of life in the cities. Through the medium of smart technologies and single smart systems, as seen in sci-fi movies presently, the interaction will be manipulated in real-time, where all parts of the urban fabric are representing components of a single smart system. Future scenario will bring us series of building networks that are able to respond to the demand of each individual user. Tall buildings will be more like living organisms, reacting to environment conditions and user demands. Within the buildings, there will be integrated networks of feedback circles, smart materials, sensors, data exchange, and automated systems.

By 2050, material production will be assembled by the robots, and current construction methods will be redeveloped, probably in building systems with self-repair options and upgrade solutions.

These predictions are based on few projects that are justifying this future movement. The Installation “Flight Assembled Architecture” is project between architects Gramazio & Kohler and robotic scientists from ETH Zurich’s Institute for Dynamic Systems and Control. The project consists of flying “quadcopters” and bricks. Each brick represents one unit, where 1,500 bricks are creating twisting tower structure. Four flying “quadcopters” are programed as digital design data and they are building 100 brick units per hour. End result is a twisting tower “vertical village” model in 1:100 scales.[76]

Future materials will be based on intelligent design with high-performance made from recycled and sustainable components, with self-repair, energy recovery, air filtering and many other functions. Hospital Manuel Gea Gonzalezes in Mexico City has intelligent double skin façade, made of Elegant Embellishments’ prosolve370e modules that reduce down air pollution with

76 Hargrave/ Wilson, 2013, 21.



[Fig.80] **Skyscrapers of 2050,** Arup has proposed their vision of an urban building and city of the future usage of superfine titanium dioxide coating. The whole system is activated with sun UV rays (ambient light), and it breaks down the pollutants, such as NOx (nitrogen oxides) and VOCs (volatile organic compounds) contracting them into CO2 and water. The system neutralizes effects of 1,000 cars in one day, as designers from design company "Elegant Embellishments" claim. In Mexico City there are 4.5 million cars registered, and that number is increasing to around 200,000 every year.[77] Besides air filtering function, Prosolve370e skin is natural light filter and it protects the building against solar gain.

Major breakthroughs are made in terms of self-repair materials. The new innovations are developed at the University of Illinois.[78] The researchers found out the way to stop process of corrosion, by using the special microscopic capsules containing a liquid healing agent added in the process of paint production. Research team at Purdue University, is focused on solar panel development with self-repair functions.[79] Self-healing concrete mixture is developed at the Delft University of Technology and it includes harmless calcite-crating bacteria along the other nutrients. In touch with water, it leads to limestone production where the holes and cracks stay fixed.

Photovoltaic components will be changed in the future and adapted to produce and store energy. This system should produce enough energy to cover vertical transportation. Some other components, such as algae bio-fuel, wind turbines that are able to convert water from humid air, air filters, recycling and water reuse systems will be integrated in the future buildings.

Engineers from Arup Company are considering some unconventional solutions for façade design, which involves live organisms and technology. They are in the process of cultivating micro algae, where in the panel's micro algae is getting water and nutrients, captivating light and carbon, and in the end producing biomass. Solar heat caught by the water, later in the process, is removed and set for building usage. Additionally, panels are used as a shading system. This system is already been used in Hamburg BIQ House.

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77 Vgl.Parker, 2013

78 Vgl. Rincon 2012, zit.n. Hargrave/Wilson, 2013, 22.

79 Vgl. Webster 2011 zit.n. Hargrave/Wilson, 2013, 22.

Chemists at the University of Texas have developed Nano materials, more precisely, tiny Nano-crystals scattered in solvent or paint, creating efficient and user-friendly way of harvesting solar energy.

Lately, many examples are proving integration of green and open spaces in high-rise buildings. Through this integration, interaction between the users and urban landscape is achieved, as well as biodiversity.

Buildings of the future will be able to optimize production, storage and consumption. It will be possible to have, if needed, food production and green spaces integrated into the buildings and smart cities.

Vertical farming concept is already possible, but for mass production it is probably still unnecessary and way too expensive. Dickson Despommier in his book "The Vertical Farm" presented concept with hydroponic and aeroponic solutions for regulating growth. Some prototypes exists in Sweden, Holland, USA and Japan.

First commercial farm based on this principle was built in Vancouver, Canada, inside of a roof top car park. This farm is providing vegetables to local restaurants on a daily basis.

In Seoul, South Korea, the three story system equipped with LED lighting is producing green vegetables, and the project is supported by South Korean government.

Over the last decade, façade design has rapidly evolved. For an example, the new façade of Q1 Building in Essen consists with 400,000 metal pieces, maintained with sensors in order to optimize light and solar gains.

New façade system has been integrated on the Willis Tower in Chicago. South façade works as a solar electric plant, where the new type of photovoltaic glass developed by Pythagoras Solar, produces energy and protects façade from the solar gain. The project has a high potential for growth, up to 2 MW in size, which is compared to solar panels about 10 acre space or 40468 m2.[80] Mono-crystalline silicon solar cells are placed

80 http://inhabitat.com/chicagos-willis-tower-to-become-a-vertical-solar-farm/willis-tower-solar-windows-2/ (13.12.2013)

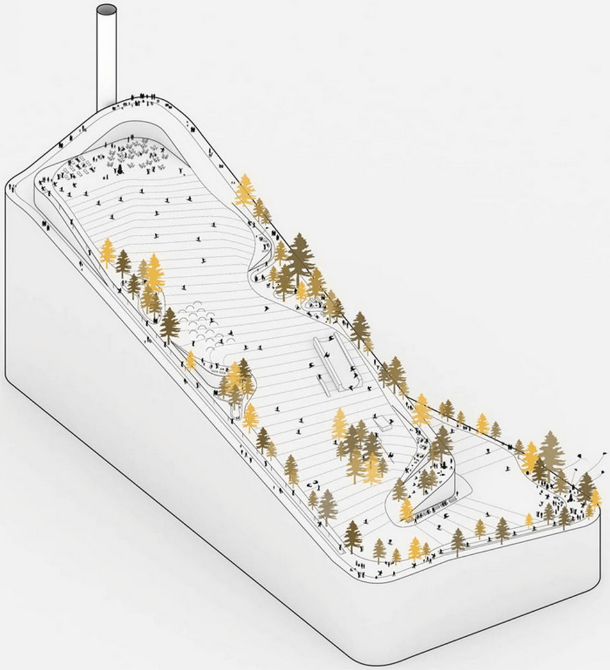
between two glass panels. The sunlight is directed to the solar cells, allowing diffused light trough.

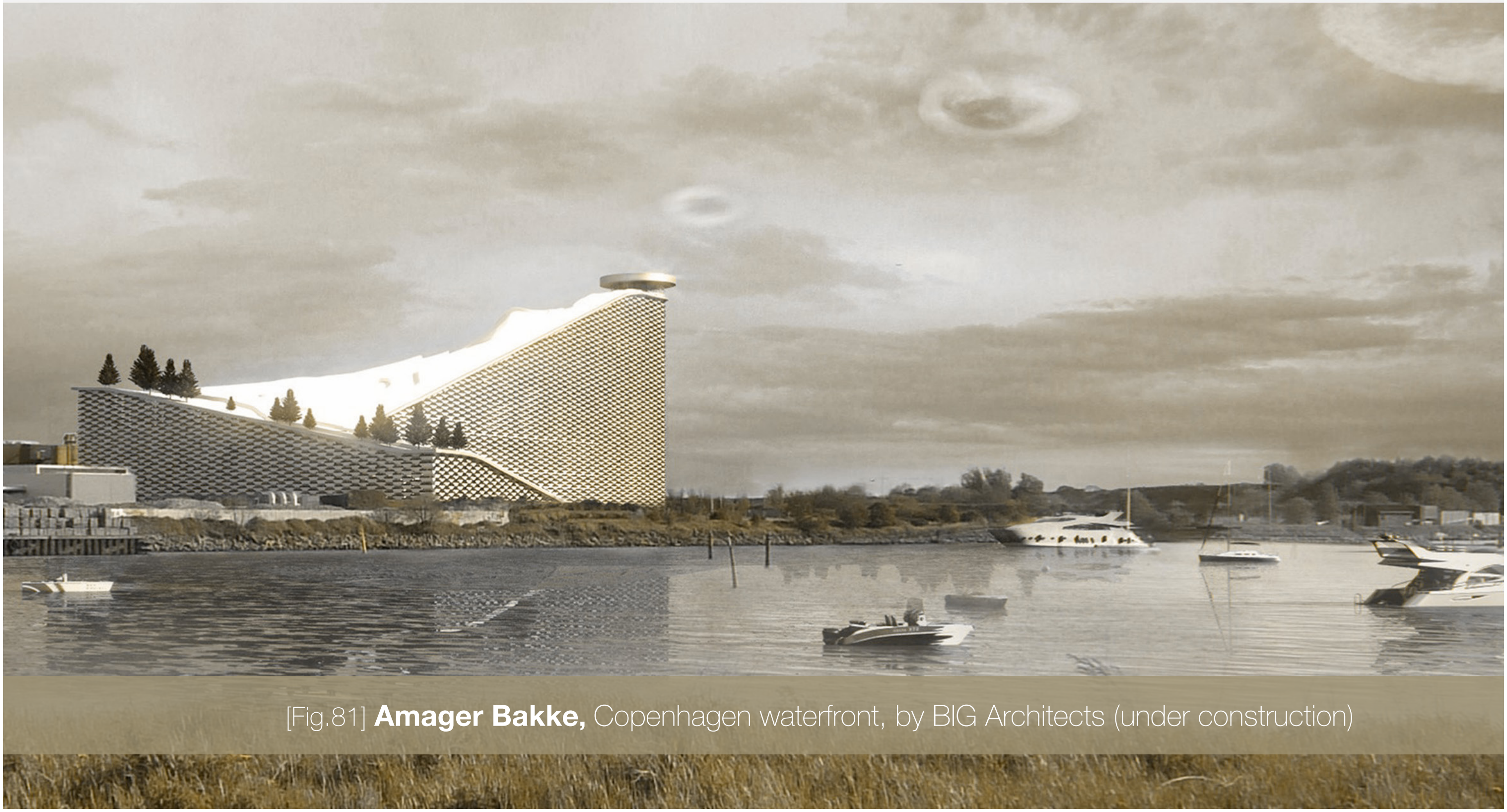
Urban surrounding and infrastructure will also be changed in the future. Transport networks, green space and landscaping will become a part of the building systems. Public spaces will be located in the tower bases, protected and connected to pedestrian networks and public transportation.

Interesting project is developed from BIG Architects, named Amager Bakke, temporary under construction. With this project BIG Architects are trying to point out the awareness of energy consumption. Amager Bakke is located on Copenhagen waterfront, a 60-megawatt waste to energy power station. On top of the facility, the ski slope will be situated . It is calculated to ensure heat for 160,000 households and electricity for 62,500 residences.[81]

81 Grose, 2013

Winter Activities





[Fig.81] **Amager Bakke,** Copenhagen waterfront, by BIG Architects (under construction)

SHANGHAI TOWER

CREATING THE VERTICAL CITY[82]

With the height of a 632m/ 2073ft and proposed 128 stories, Shanghai Tower will become a new landmark and one of the tallest buildings in the world. It is located in the middle of Shanghai's new finance and trade zone, Lujiazui district, next to the Jin Mao tower and the World Financial Center, one of the world's famous commerce destinations. This project is not just a commercial 'megatall' tower; instead, it is a tremendous super high-rise design that represents the next step in creating modern cities.

It is a sustainable tower that has mixed-use functions, such as restaurants, shops, offices, and hotels connected with the public spaces and sky gardens.

The public space is placed vertically within intervals and provides a community services for users and visitors. The building is enveloped from the bottom to the top, and intersected with private areas, public spaces, and sky gardens.

One of the principle designs of Shanghai Tower is the traditional lane house idea, where users (families) live closely by the communal open space. Instead of the traditional horizontal plan, the Shanghai Tower plan is based on vertical neighborhoods with its own 'sky gardens' in order to create community synergy. Shanghai government required that 33% of the site needs to be reserved for green space and traditional Chinese landscape with temples, towers and gardens. The park must accommodate diverse activities for everyone.

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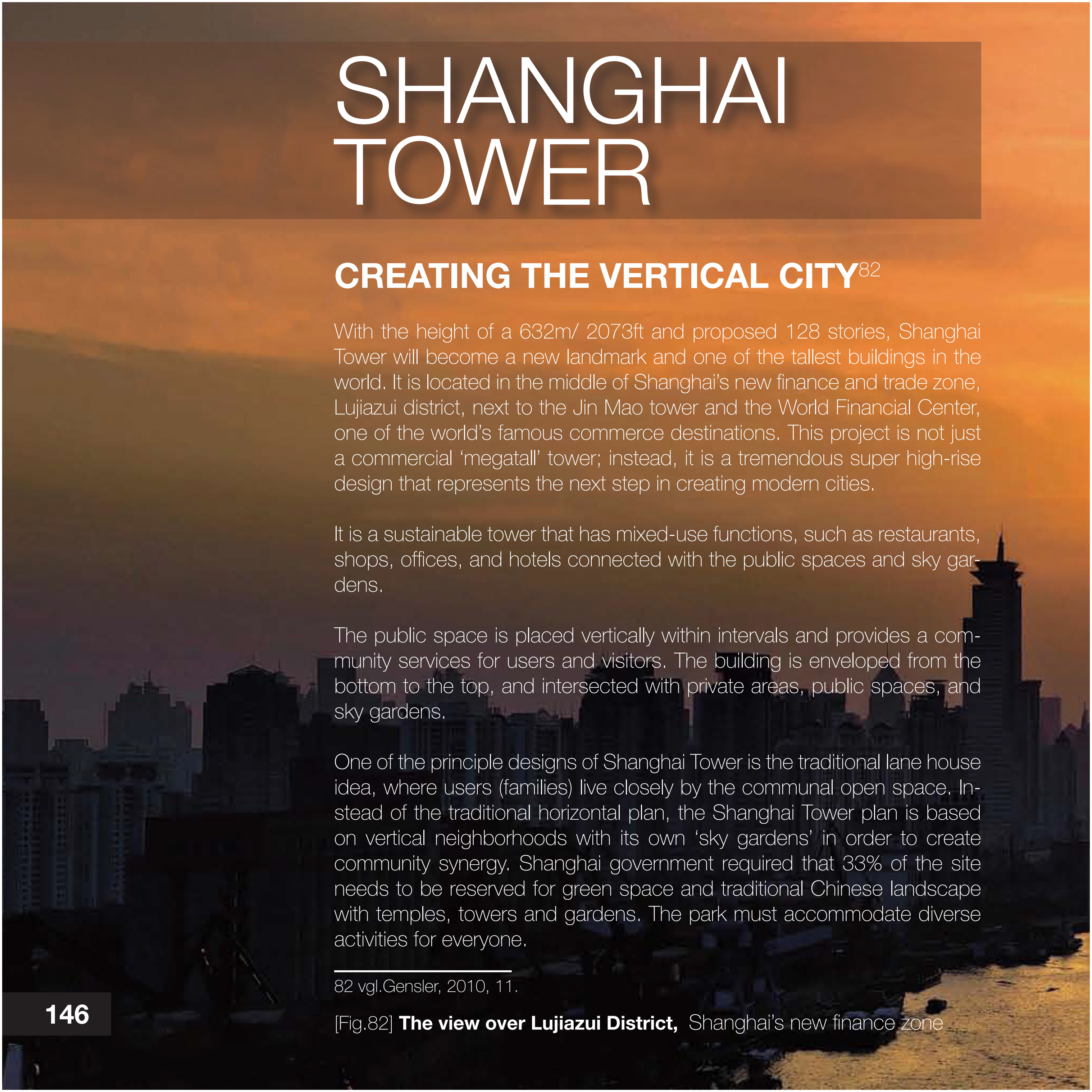
82 vgl.Gensler, 2010, 11.



[Fig.82] **The view over Lujiazui District,** Shanghai's new finance zone

SITE

LOCATION: Lujiazui Finance and Trade Zone, Pudong district, Shanghai, China
AREA: 30,370 m^2

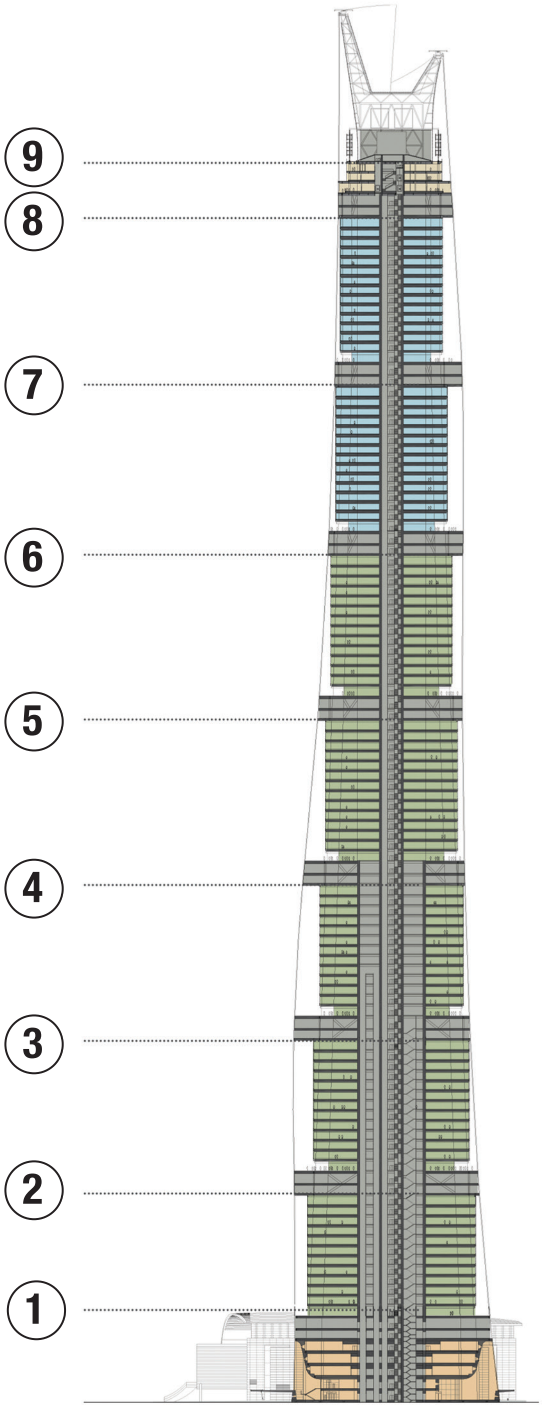
TOWER

HEIGHT: 632 m
STORIES: 121 occupied floors
AREA: 380,000 m^2 above grade
141,000 m^2 below grade
PROGRAM: Office, luxury hotel, entertainment, retail, and cultural venues

PODIUM

HEIGHT: 36.9 m
STORIES: 5 stories above grade
AREA: 46,000 m^2
PROGRAM: Luxury retail, bank, restaurant, conference, meeting, and banquet functions. Below grade levels will be house retail,1,800 parking spaces, service, and MEP functions.

TOWNER, DEVELOPER, CONTRACTOR:
Shanghai Tower Construction & Development Co.,Ltd.
DESIGN ARCHITECT:
Gensler
LOCAL DESIGN INSTITUTE:
Architectural Design & Research Institute of Tongji University
STRUCTURAL ENGINEER:
Thornton Tomasetti
MEP ENGINEER:
Cosentini Associates
LANDSCAPE ARCHITECT:
SWA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Tower Design

Design team Gensler and engineering companies Thornton Tomasetti and RWDI, in the process of tower design, used three important concepts to reduce typhoon-level wind loads: the asymmetry of façade, narrowing shape, and frequently rounded corners. Thornton Tomasetti and RWDI partner engineering firms created series of wind tunnel tests stimulating weather conditions common to Shanghai. The outcome was a shape of tower that reduces lateral loads by 24%, where each 5% of reduction saves about 12 million US$ in construction costs.[83]

Nine vertical zones shape the program of Shanghai Tower:

ZONE 1 – retail podium with cafes, lounges, luxury shops, restaurants

Zones 2-6 – are reserved for office floors connected to sky gardens as community assembly space

Zones 7-8 – five star hotel, with conference, banquet and spa facilities based on six-story podium with divided office, housing and hotel lobbies.

Zone 9 – open and enclosed observation decks and restaurants, connected with future tallest single –lift elevator in the world, detached from other tower Zones and directly connected with parking links and ground zero walkways.

From the ground floor and upwards, each tower zone begins with a sky lobby, which has a function of traditional town plaza. Sky lobby is designed to be a connection point with tower's mixed used program, a place for gathering, where a light-filled garden atrium gives a sense of historic open courtyard.

83 Vgl. Xia/Poon/Mass: 2010, 13.

[Fig.83]- left - **Shanghai Tower,** night rendering and cross section

The main aspect of design is a double transparent skin façade. Second skin wraps/envelops the entire building. “The ventilated atriums it encloses conserve energy by modulating the temperature within the void. The space acts as a buffer between inside and outside, warming up the cool outside air in the winter and dissipating heat from the building interior in the summer.”[84]

Mechanical system is integrated in each zone of the building and likewise, it secures ideal energy usage and is cost efficient.

Structure

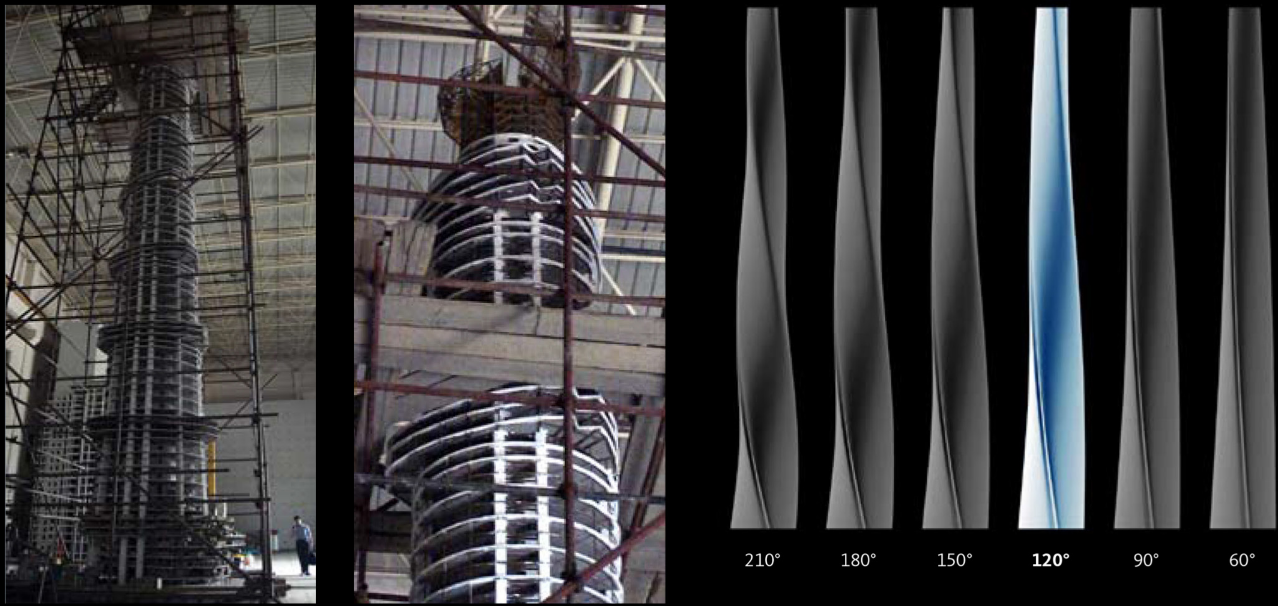
Structure must fulfill many demands. It needs to be resistant and elastic, because it is located in an active earthquake zone with very windy climate and clay-based soils.

The main part of the structure is a 30m square concrete core. The core is connected with structural steel outrigger truss and composite (concrete covered steel vertical sections) supercolumn system. The system is enclosed with four paired and four diagonal supercolumns along 45-degree axis. Diagonal supercolumns are needed because of the long distances between the main supercolumns at the base. Distance between diagonal and main column is approximately 25m.

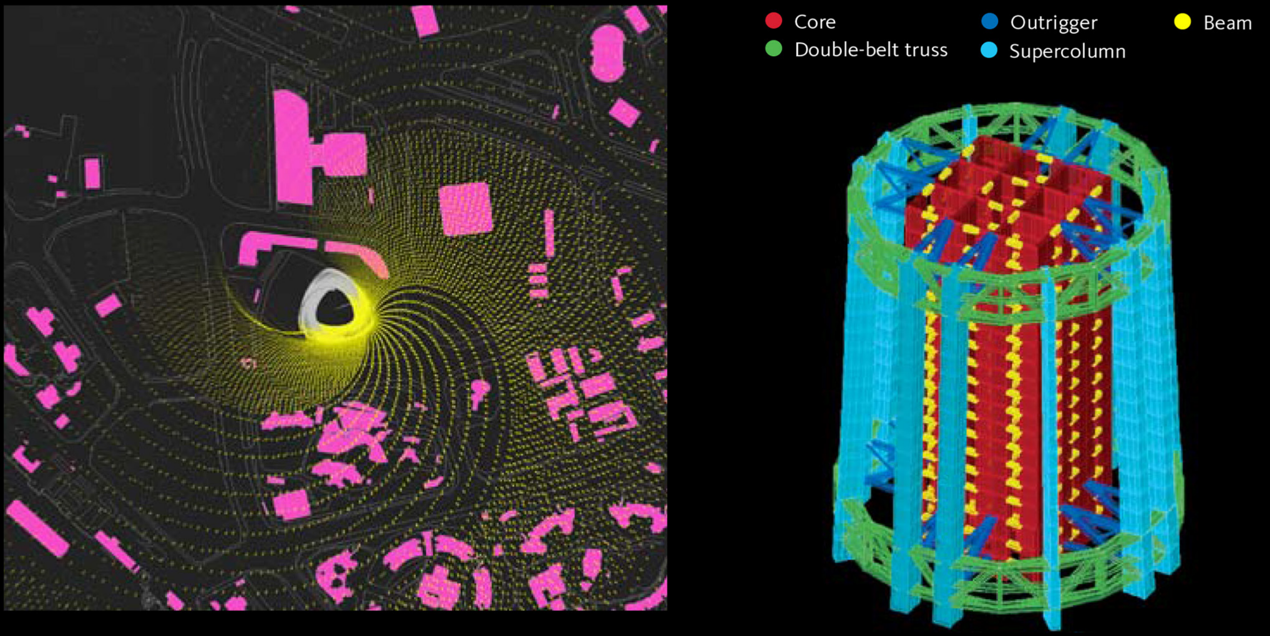
Nine zones, each zone with 12-15 floors, are vertically spreaded within the tower. Two-story mechanical area is based on the top of each tower, with mechanical, electrical and plumbing equipment. Mechanical floor is planned as a safety escape area.

The typical soil of Yangtze Delta River is clay soil, and the whole area is very seismically active, resulting- as defined in the China Building Code as type IV-with a tower foundation of 1m in diameter and 52-56 m long bore piles. Overall, the tower foundation is supported on six meters deep mat with 947 bore piles.[85]

84 Xia/Poon/Mass: 2010, 14.
85 Vgl. Xia/Poon/Mass: 2010, 14.



[Fig.84] **Earthquake Simulation and Wind Tunnel Tests**



[Fig.85] **Light reflectance off the curtain wall and Tower Structure**

The tower has special curtain wall design with two separated curtain wall systems. The inner skin is circular, and exterior skin is cam-shaped with rounded corners similar to a guitar pick. The separation between the two systems creates space for atria every 12-15 floors. With higher heights, the exterior skin cam-shaped plan is reduced in size and becomes thinner. Also, the cam-shaped plan is slightly twisted around the central part through each higher zone, giving an elegant and spiraling shape of the building.

The main aspect of Shanghai Tower is sustainable design development. The project has earned LEED Gold rating and China 3 Star rating for sustainability. The water treatment plants are integrated in the tower with the goal of recycling grey water and storm water needed for watering and toilet flushing.

Water treatment plants are located within the tower, podium and basement level to decrease pumping energy. The interim water is utilized in storage tanks within the building, and later on used on the principle of gravity. The only energy used for water transport is low-pressure pumping energy, which provides water to each tank based on a cascading effect that results in 38% of reduction in water consumption.[86]

86 Vgl. Xia/Poon/Mass: 2010, 17.

Shanghai Tower is targeted to reduce water consumption by:

38%

Shanghai Tower is targeted to reduce energy use by:

21%

[Fig.86] **Typical Zone Section,** perspective view

Cutting and dividing tower into vertically stacked zones reduces the energy required for vertical transportation within the tower, because of the central utility infrastructure and vertical city design concept. It is calculated that Shanghai Tower saves approximately 20 million RMB (2.43 million €) annual energy costs compared to the ASHRAE 90.1-2004 baseline.[87]

The Tower integrates two chiller plants. The Low Zone Chiller Plant consists of 27,000-Ton Hours of ice storage and it supplies the facility up to the 65th floor. The High Zone Chiller Plant is on the 82nd and the 83rd floor. Those plants reduce transport energy of chilled water.

Natural gas-fired cogeneration (combined heat and power -CHP) system provides Low Zone areas with electricity and heat energy. “The system provides site-generated power while producing 640 Tons of refrigeration during the cooling season and heat during the brief winter months. Site – generated power has the advantage of reducing source energy consumption and the carbon footprint of the facility by utilizing clean-burning natural gas in lieu of high-sulfur coal.”[88]

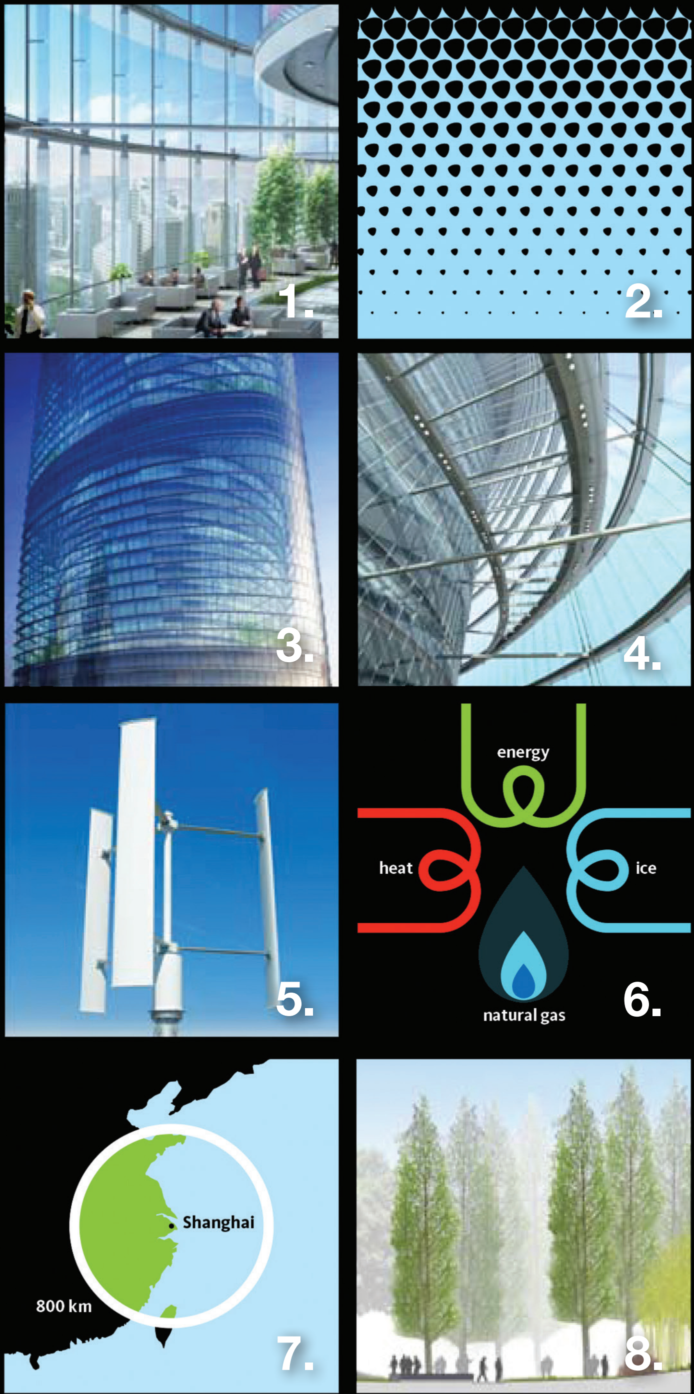
High-pressure steam is used by the tower’s HVAC system, generated in Low Zone Central Plant to obtain the heating and domestic water heating system.

Ventilation systems, electrical transformers, and water systems are located in the mechanical floors, and from there, the occupied zones above and below are maintained.
Before being provided to the occupied zones, the outdoor air is pre-conditioned, filtered, and measured.

“Electrostatic filters on the outdoor air systems reduce fan motor horsepower and rotary heat exchangers between the outdoor air and exhaust air streams reduce the heating and cooling energy required to pre-condition the outdoor air.”[89] The used indoor air is driven to the atrium before being exhausted from the building. In this case, the atrium acts as a “buffer

87 ASHRAE 90.1- 2004 baseline, Energy Standard for Buildings Except Low-Rise Residential Buil.
88 Xia/Poon/Mass: 2010, 17.
89 Xia/Poon/Mass: 2010, 17.

[Fig.87] **Sky Lobby's,** outer curtain wall create courtyards that serve each of the vertical zones



1. DAYLIGHTING
2. SUN-SHADING

3.BUILDING ENVELOPE
4. BUILDING CONTROLS

5.WIND TURBINES
6.COGENERATION SYSTEM

7.REGIONAL MATERIALS
8.LANDSCAPING

[Fig.88] **Green Strategies**

zone"[90] around inner façade.

The exterior curtain wall skin is utilized from several systems, in order to reduce solar load, glare and heat build-up. Fritted-glass surface should provide sun shading, where fritting covers 25% of the typical glass panel (26mm laminated low-iron glass with selective low-E coating). Furthermore, at the end of every floor, the tower form is building a horizontal layer extending out and up to 600mm, which provides shading effect as well. The last layers of protection are 350mm glass fins reinforced on aluminum frames in order to bend some daylight illumination.

Innermost curtain wall system is built on a similar principle like the exterior skin, in order to reduce sun radiation and to provide shading, using 30mm isulated clear glass with selective low-E coating, partial fritting, mechanical controlled interior roller shades and vertical non-operable shading fins.
HVAC system is controlling and monitoring outdoor air distribution, levels of CO2 and tobacco smoke. The window openings and the natural ventilation system is adapted and maintained to the weather conditions and poor air quality in Shanghai, and not primarily to the building height.[91]

90 Xia/Poon/Mass: 2010, 18.
91 Vgl. Xia/Poon/Mass: 2010, 12-19.

[Fig.89] **Greenland Group Suzhou Center, Wujiang**

Greenland's Suzhou Center, Wujiang

Greenland's Suzhou Center is a collaboration project between Skidmore, Owings & Merrill and the Greenland Group, designed to be an innovative and new visual landmark tower, sited along the Lake Taihu, the new development of Wujiang city in the Jiangsu province of China.

It is an energy efficient tower design, based on innovative passive ventilation techniques and visual representative aerodynamic form, designed to be a "breathing tower", with height of a 358m, 75 stories, and more than 284,000 m2 area mix-used program, such as office, residential, hotel and retail. Through the usage of several independent lobbies at the ground floor, each function can operate separately.

The tower is oriented in the east-west direction, in order to use the benefits of environmental factors, sun radiation and wind direction data (stack effect), and to take the full advantage of its surroundings, pedestrian paths and lake promenade.

The Wujiang Greenland Tower's composite core and outrigger system provides many advantages, especially position of the split-core in upper floors. The central core splits in two parts and it is interconnected with structural steel braces. This system is more effective than the typical center core, because it provides more space between cores and reinforces the tower structure. The sky-bridges in upper atrium floors are connecting the two separated parts of the building, allowing active pedestrian circulation within the tower. The tower is supported by pile mat foundation and has three basement levels.

The Breathing Tower[92]

The tower geometry and form is driven by aerodynamic modeling techniques, resulting with soft curvilinear shape of the building. This project is designed and placed to get an advantage of the natural wind flow, despite of wind direction, where the atrium becomes the main design component. Wind patterns are different from season to season, and sometimes direc-

92 Wimer/Baker/Nagis/Mazeika, 2012,14.

tion changes few times in one day. In order to take the full advantage of the wind flow, the wind is driven by systems of digital controls, integrated in tower, which measure and direct air into atrium. The system digitally controls window opening and closing and literally imitates the process of "breathing", where the tower atrium functions as a "lung". [93]

Environmental strategies

In order to get LEED-CS Silver rating status, the tower combines different energy saving measures from ASHARE 90.1 2007 baseline. The Wujiang Greenland Tower is designed to reduce energy consumption and provide energy conservation, with many effective measures, such as rainwater preservation, condensate recovery and useful usage of processed water, façade optimization and mixed-mode ventilations in the tower's open spaces and private areas. It is predicted to save 50 % in water costs, compared to the Energy Policy Act of 1992.[94] The fresh air is injected into the building from the large openings located on the tower's top, and the reason for it is the poor outside air quality, especially at the lower floors. Atrium façade (openings on the top and the bottom of the atrium) is controlling fresh air intake and directly ventilates apartments and hotel rooms with cool air in hot summer days. The usage of natural ventilation is not always attainable, and in those situations, the offices, hotel rooms and apartments will be maintained with speed fun coil units. Warmer interior air temperature, in the winter months, is provided through the vertical stack in atrium, or otherwise, trough usage of fun coil units and additional under floor radiant heating.
The meteorology data shows wind direction annually, where the wind moves from northwest to northeast/east or through southeast, especially in the summer. During the southeasterly winds in the summer, natural ventilation will be set in south office areas.

Atrium façade maximizes daylight, using daylight responsive control, which automatically reduces consumption of energy needed for artificial lightning.[95]

93 Vgl. Wimer/Baker/Nagis/Mazeika, 2012,12.
94 Vgl. Wimer/Baker/Nagis/Mazeika, 2012, 15.
95 Vgl. Wimer/Baker/Nagis/Mazeika, 2012, 16-17.

[Fig.90] **Suzhou Center contextual plan**

[Fig.91] **The Hansar, Bangkok,** by WOHA (2011)

The Hansar, Bangkok

Finalist of CTBUH Award “Best Tall Building Asia & Australia” in 2011
The Hansar is a 43-storey hotel and residential building, designed on sustainable and tropical living strategies, based on natural ventilation and shading, and passive energy techniques.

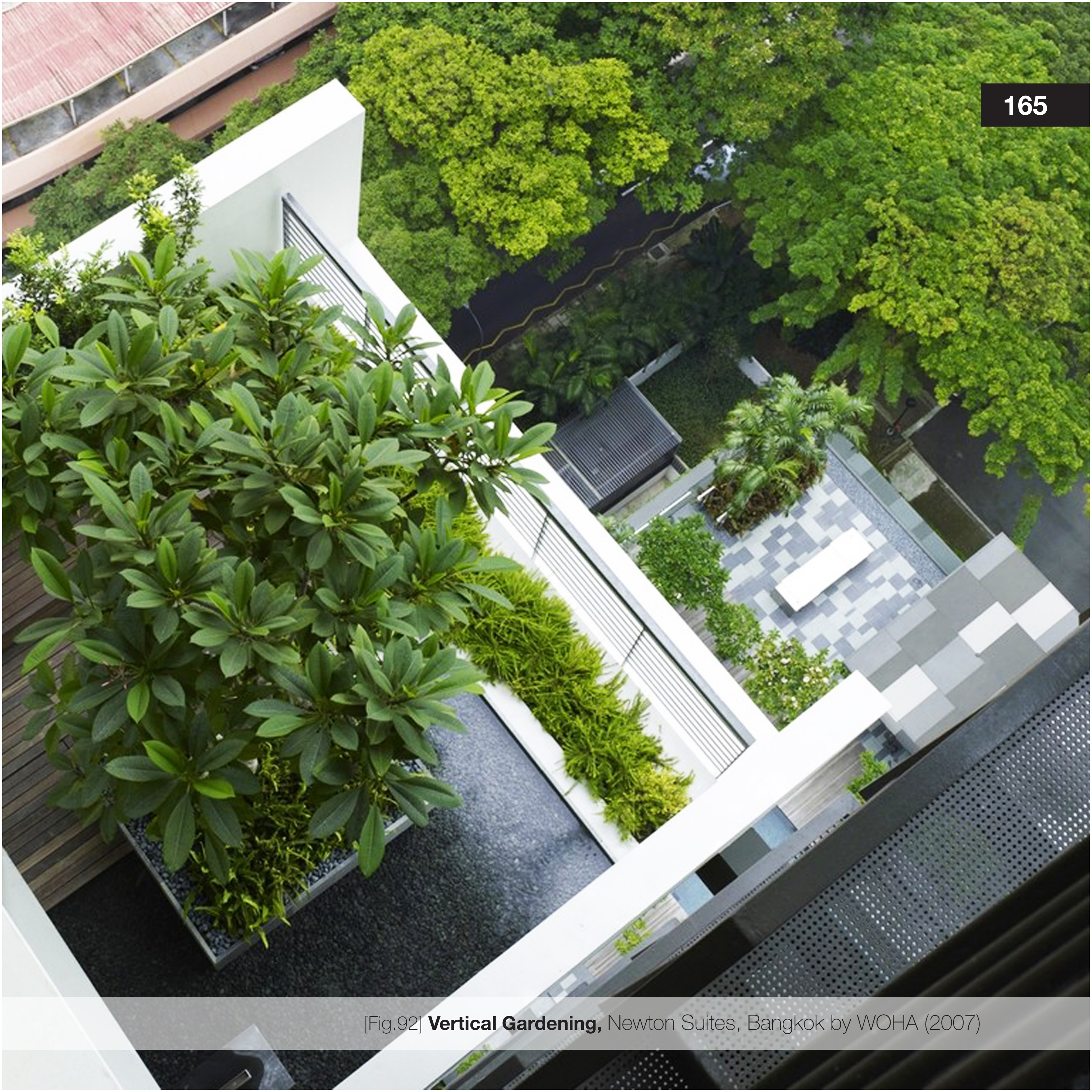
Bangkok is one of the major financial and economic centers in the South-east Asia, and the capital city of Thailand, with the city area of 1,569 km2 and population of nearly 8,5 million. The overcrowded city is well known for the traffic jams and the highest automobile ownerships in Asia, which results in poor air quality. Bangkok is currently in the process of a rapid modernization and the construction industry is still increasing. After Great Andaman Earthquake on December 26, 2004, design methods and seismic regulations for building above 15m have been changed. Prior to the earthquake in 2004, high-rise buildings were mostly designed to resist lateral wind loads. Bangkok’s climate is hot and humid, with temperatures between 26 and 31 °C. Three main seasons are shifting in Bangkok: hot (April-May), rainy (June-October) and cool (November-February). In those circumstances constructing the high-rise buildings have mass advantages, like having an open view, more privacy and better security, less humidity, stronger and cooler wind breezes, less insects and noise, and less dust.
WOHA design architectural team uses different design techniques in their Bangkok projects, avoiding almost standardized glazed curtain wall systems and full mechanical maintenance of indoor spaces. In projects ‘The Met,’ ‘The Pano’ and ‘The Hansar’ in Bangkok and Newton Suites in Singapore (Skyrise Greenery Awards 2008), the design principle is based on repose to climate conditions, adding nature, landscaping and external community spaces. Furthermore, the indigenous and passive techniques have been integrated. The result is extra comfort with highly reduced demand for mechanical systems.

The Met building is a 69-story residential tower, clearly not just a stacked floor building, incorporated with external community spaces, green facades, sky gardens, covered walkways, open-air living areas, barbecue areas, library, fitness and recreational spaces available on every 20 stories, where residents and users have a chance to access to view decks on high-levels and open air terraces. Private gardens with additional swimming pools and terraces are based on every six stories. Basically, the apartments are considered to be small garden houses, where every condo has an open-air void through the tower height. Pocket gardens are designed next to the lift lobbies trough the tower height, with an open view on the river and the city.

The Hanser building is located just off to the Sukhumvit Road, Bangkok's main commercial, retail and entertainment area, enclosed with large city park, luxury hotels, apartments and shopping centers. Within a short walking distance, Ratchadarmi BTS Skytrain Station and Si Lom MRT Subway Station are reachable, as well as the elevated walkways and pedestrian networks. The best views are oriented towards the east in direction of the Lumpini Park and west to the Turf Club.

The building is set on a small and irregular site, with 1:10 plot ratio. On a zero level of the Hansar building, there is a lively street retail, with restaurant, bar and outdoor dining garden terrace, attractive and easy accessible for pedestrians. The Hansar building is divided into low, mid and setback high-rise zone, and each zone has a different design approach. The low zone is considered as slab block, the mid zone as a courtyard block and the high-rise zone as a tower around the central service core. The Hansar has a simple structure, and it is made from the concrete reinforced frame around a rigid central core.

Furthermore, the building is intercepted horizontally with sky gardens at every fifth floor, within regular rhythm, on both east and west part of the building, planted with mature frangipani trees. The sky gardens, serving cool and natural relaxation, are in this case structurally tight four slander tower blocks. Every floor is shaped with landscaping, where every unit has the view on a sky garden or a private lift lobby with direct connection to the sky garden. Landscaping serves as physical buffer between the neighboring apartments, creating feelings of comfort and privacy.
The Hansar building is opening up to the climate, naturally ventilated, based on indigenous and passive techniques, perforated, shaded and with fully green design. After 1980s, in South East Asia, mostly tall buildings have been designed on a principle of curtain wall, where every unit required only air conditioning and mechanical ventilation for maintenance. The Hansar



[Fig.92] **Vertical Gardening,** Newton Suites, Bangkok by WOHA (2007) is based on the opposite principle, with series of techniques that reduced temperature gain and humidity, bringing fresh air and landscaping into the building, where tropical and sensible climate becomes comfortable for living. The WOHA Architects have explored low-rise tropical housing, adapting and integrating those amnesties in the high-rise building.

Cutting building vertically and integrating sky garden pockets throughout the building height, putting living areas around central core and courtyard, cross ventilation of all units and natural ventilation of most restrooms have been accomplished. Sunshades have been integrated in front of the living units in order to provide cooler interior. Most units have additional balconies attached to the frontage.

The low-rise block contains elevated six stories of car parks, which provides a secure platform for cars in case of floods that are common in Bangkok's city area. In order to reduce the solar gain from the vertical surfaces, shading wall method proved to be effective. Inexpensive metal mesh is covering vertical façade, and protecting the building, but also regulating light and air. Air-condition units and utility zones are set in the back of structural columns, covered and hidden from the public view.

As mentioned before, the Hansar building provides external and community spaces in the sky, for public and private usage. Based at the top of elevated ground (the 8th floor), are the communal recreational terrace with fitness and yoga room, lounge deck and swimming pool. Event terrace is introduced on the 19th floor.

In WOHA's high-rise designs, environmental quality is achieved through the usage of vegetation, and enriches both the interior and exterior of the building. The Hansar is limited with a small site, and the green areas have been lifted in the air. Sky gardens are equivalent to 30% of the Hansar site area. Units in the lower levels have cantilevered gardens. The dynamic of green elements is vertically spread throughout the whole project. Most hotel rooms have sky pavilions with green walls. At the podium, the hanging green wraps are integrated around the building.[96]

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96 Vgl. Wong/Hassell, 2012, 12.-17.

[Fig.93] **Typical hotel room with green wall**

[Fig.94] **Swimming pool over podium**

hong kong

hong kong

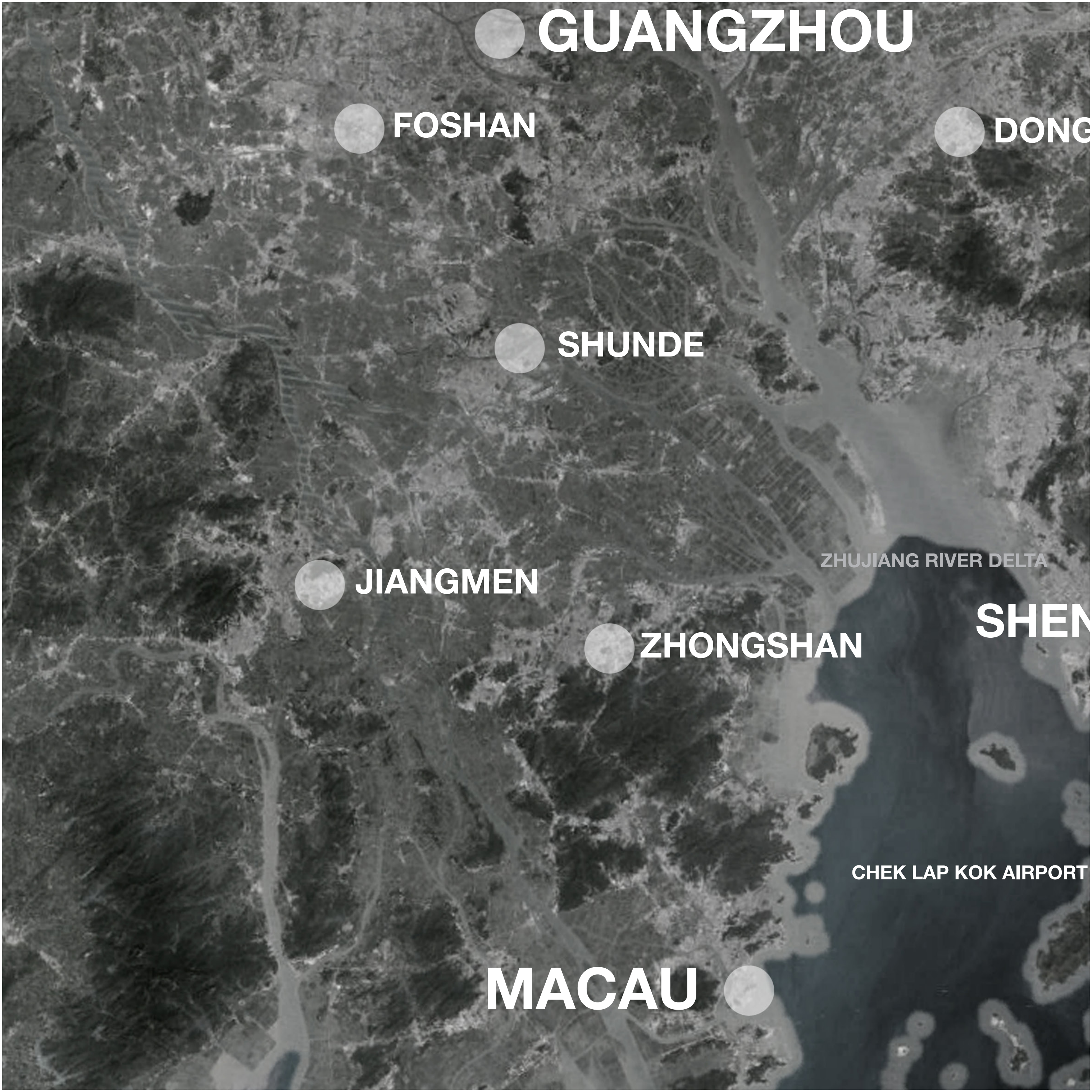
Since the 1841 and the British colonial rule, Hong Kong was a city-state and more recently known as a Special Administrative Region (SAR) of the People's Republic of China (PRC) with semi-autonomous status. Hong Kong is located on the south Chinese coast, surrounded by the Pearl River Delta and the South China Sea. It has a territory of 1,104 km2, with population of 7.15 million estimated by the Hong Kong's government in 2012. Hong Kong is one of the densest areas in the world. It is well known for impressive skyline and deep natural harbor. On Cantonese or Hakka language, the name "Hong Kong" means "fragrant harbor". Hong Kong's topography is impressive as well, and it consists of over 200 islands, steep hills and the sea. The infrastructure in Hong Kong has a linear orientation and compact grid because of the almost unbuildable landscape.

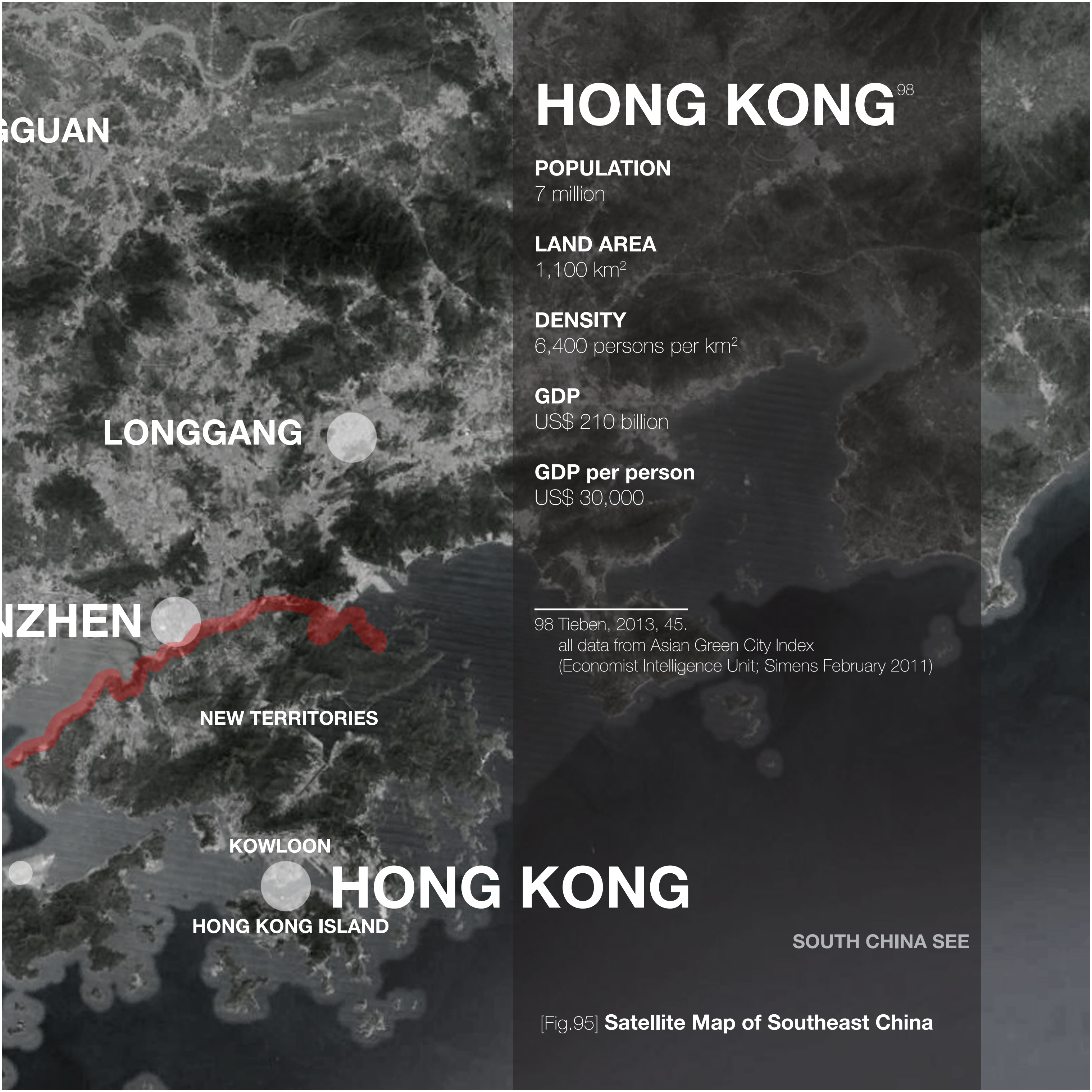
According to Hong Kong's Department of Statistics in 2008, the population of Hong Kong Island on the area of 20 km2 of developed land was 1.3 million people. Just 25% of Hong Kong Island (80 ha area) is urbanized, where 75% are parks and mountains.

Because of the high economic growth, impressive topography and infrastructure, the city of Hong Kong is highly convenient for living, and it attracts business partners and tourists from all over the globe. Hong Kong has a high position on economic powerhouse, and it is recognized as an elite international finance center, one of the major logistic and knowledge centers. It is also well known as a low tax and free trade zone. The Hong Kong Stock Exchange is one of the largest in the world. Chep Lak Kok Airport is one of the biggest and busiest cargo airports in the world. The Hong Kong's port is the third busiest container port in the world, immediately after Singapore and Shanghai. In 2011, Hong Kong's GDP per capita (US$ 49,800) outstripped that of Switzerland (US$ 43,900). Unfortunately, like in many other neoliberal country policies across the world, there is a huge gap between very rich and very poor people. From 7, 15 million inhabitants in Hong Kong, 1, 3 million is still living in poverty.[97]

The Hong Kong's architecture was not meant to be purely esthetic, but rather rational and efficient, a direct answer to specific conditions, like topography, climate, economic and political factors.

97 Tieben, 2013, 46.


GUANGZHOU
FOSHAN
DONG
SHUNDE
ZHUJIANG RIVER DELTA
JIANGMEN
SHEN
ZHONGSHAN
CHEK LAP KOK AIRPORT
MACAU



HONG KONG[98]

POPULATION
7 million

LAND AREA
1,100 km^2

DENSITY
6,400 persons per km^2

GDP
US$ 210 billion

GDP per person
US$ 30,000

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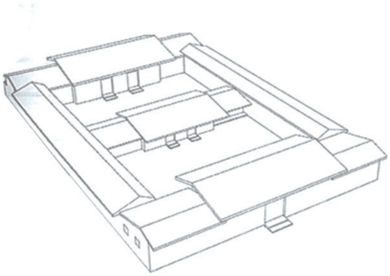
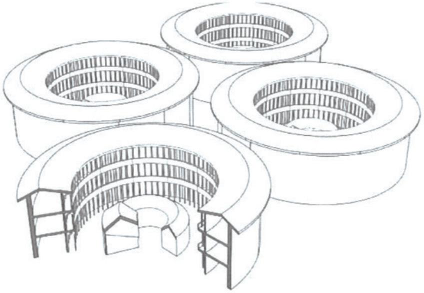
98 Tieben, 2013, 45.
all data from Asian Green City Index
(Economist Intelligence Unit; Simens February 2011)

[Fig.95] **Satellite Map of Southeast China**

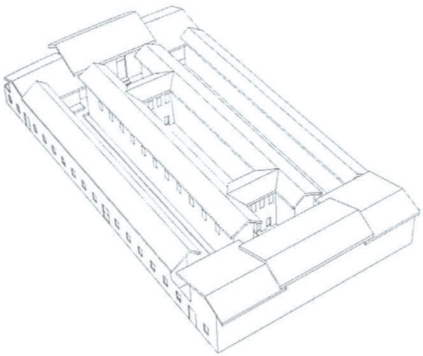
_typology [Fig.95 b]



chinese courtyard house



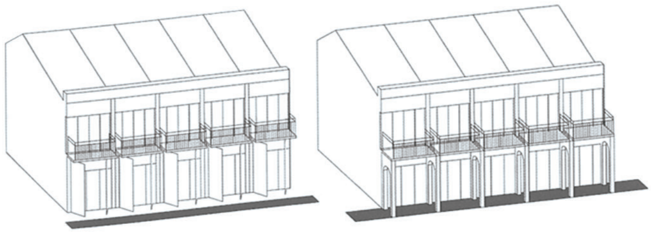
hakka walled settlement



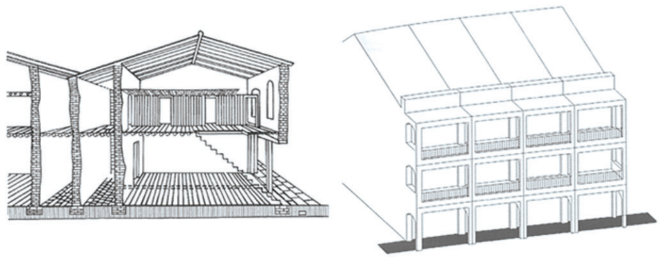
walled village of Tsan Tai Uk, Hong

traditional form of dwelling in China

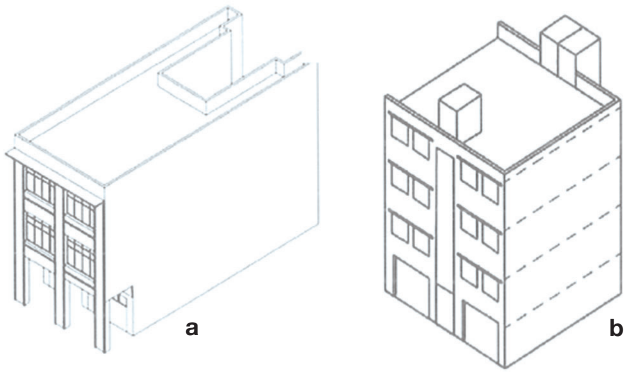
hong kog's urban beginnings



Penang shop houses - earlier (left) and later (right)

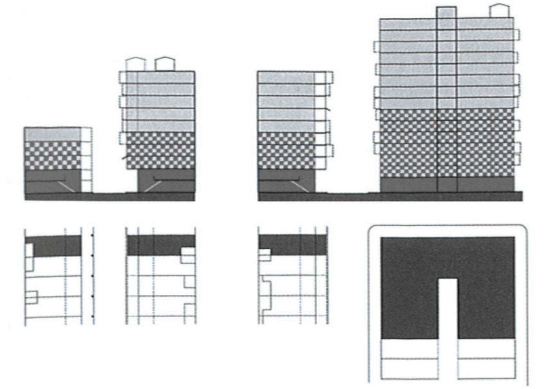


early form of shop house - two storeys without colonnade (1882)
later form of shop house - three storeys with colonnade, balconies and footway

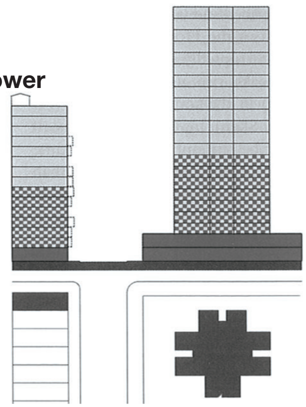


shop house with colonnade (1945) **a**
flat-fronted variation of shop house (1950) **b**

rising up (post war deacdes)

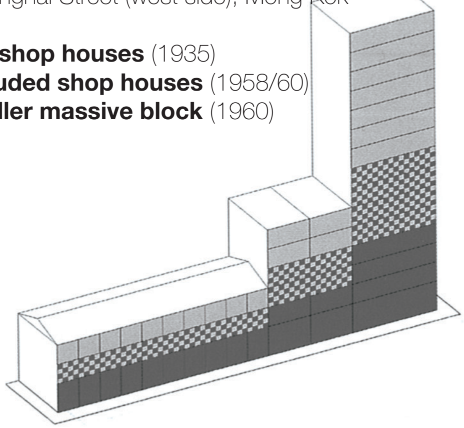


changing street and building form
- **from shop house**
- **cantilevered forms**
- **massive block**
- **early podium and tower**

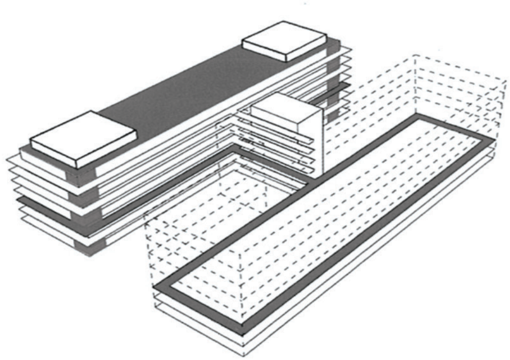


One-block section
of Shanghai Street (west side), Mong Kok

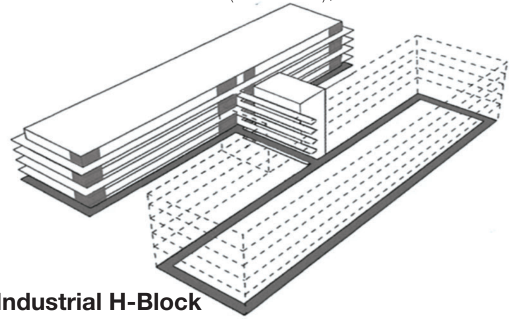
- **row shop houses** (1935)
- **extruded shop houses** (1958/60)
- **smaller massive block** (1960)



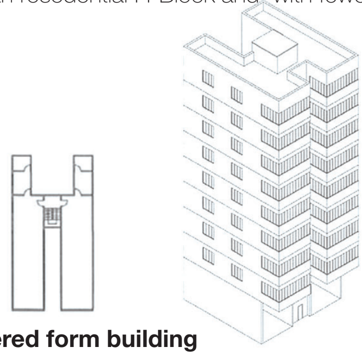
more height than mass



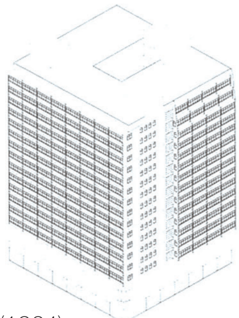
resedential H-Block (1950-60), circulation scheme



Industrial H-Block
(larger than resedential H-Block and with fewer levels)

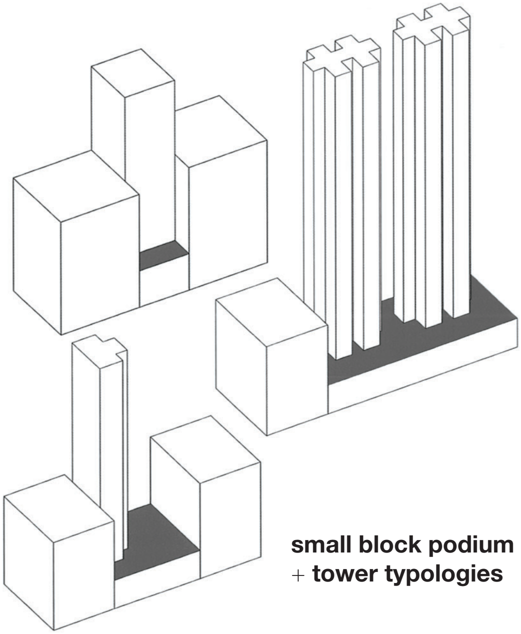


Cantilivered form building
extruded from shop house (1960)

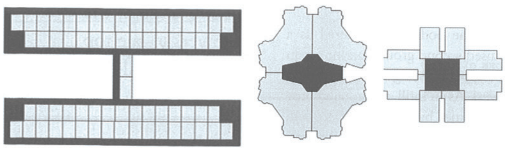


massive block (1964)

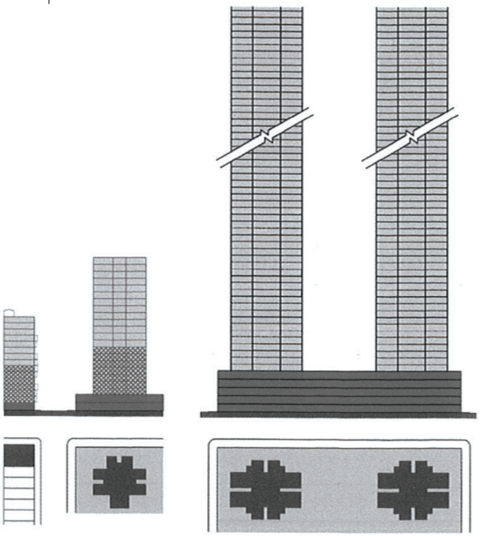
podium and tower



small block podium
+ **tower typologies**

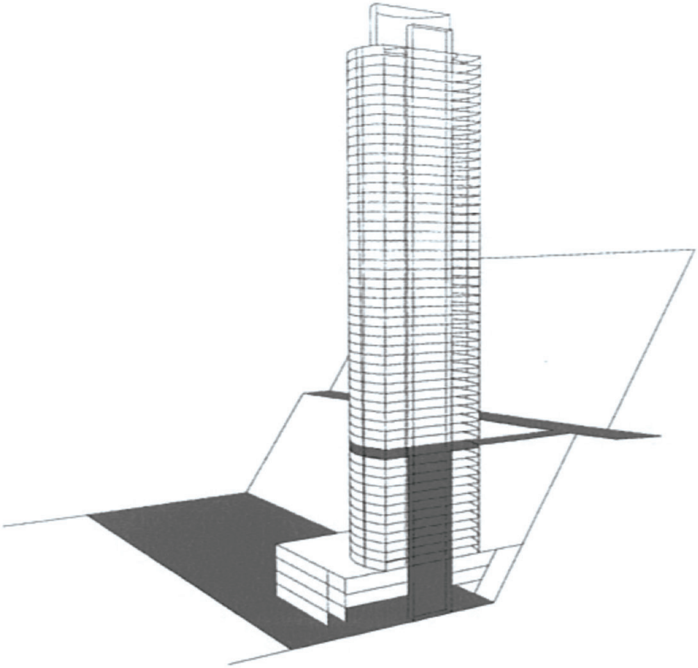


efficiencies in circulation,
comparison between slab and tower forms

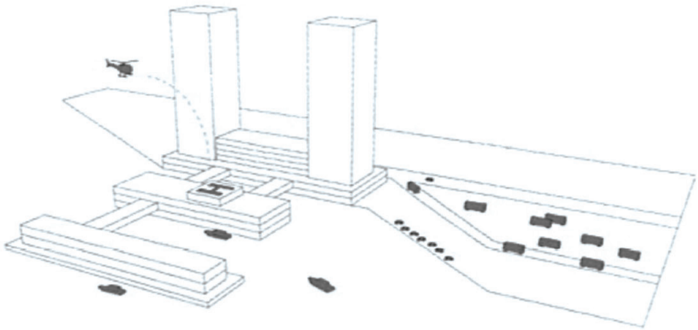


change in size towards the end of 20 th century

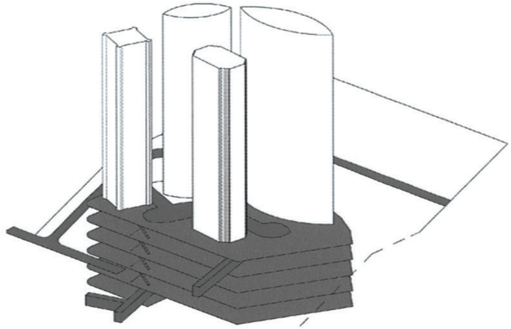
redefining ground



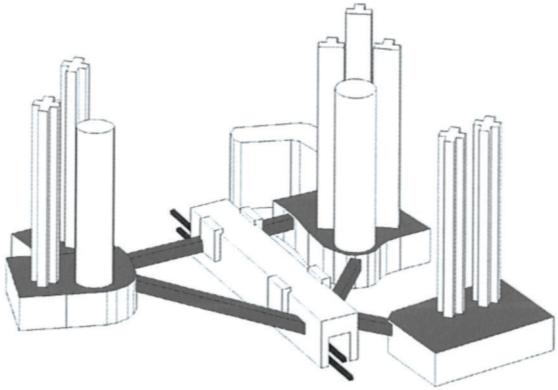
split ground



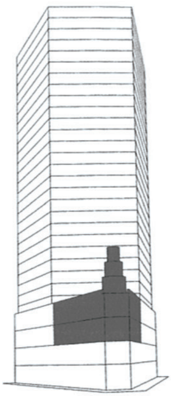
multiple ground - Shak Tak Centre/Macau Ferry sky typologies

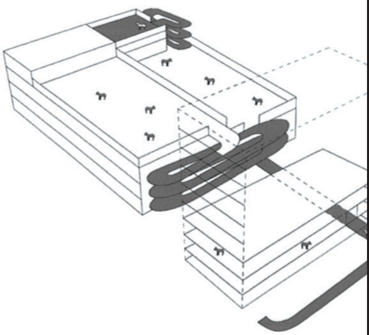


Pacific Place connection point, routes from Wanchai, Central, Admiralty and Mid-levels



linking between towers and station over podia





multi level developmant
the church above shop,
between Hennessy and
Johnston Roads, Wanchai

multi level composition

landmark icons

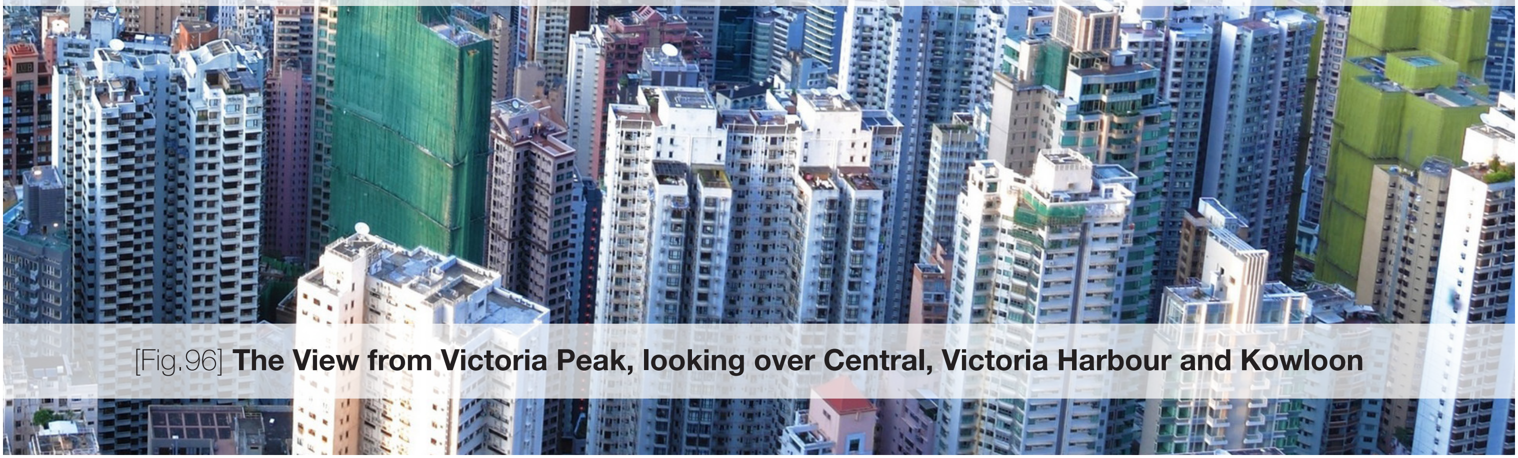
International Finance Center (IFC)

"Nowhere do buildings stand more dramatically in the topography. Nowhere else in such an extreme density so radically and so expressively transcribed into built architecture. The overwhelming extensiveness of repetitive non-ending structures appears almost surreal. […] Everything is somehow fantastic and simultaneously so evident."[99]

99 Christ/Gantenbein, 2012, 03.

"With 13 m^2 per person, Hong Kong's medium living space is lower than most parts of the developed world and Mainland China."[100]

100 Tieben H., 2013, 46.



[Fig.96] **The View from Victoria Peak, looking over Central, Victoria Harbour and Kowloon**

Urban Transformation of Hong Kong

The Hong Kong government's first major step into public housing came after the big and tragic disaster in squatter settlement of Shek Kip Mei on Christmas Eve in 1953. After that tragedy, Hong Kong become very organized and the city with clear vision ahead. Many tragedies shaped the city of Hong Kong over decades, but after hard times, this city became even more livable and beautiful. Similar story happened in 2003, when the SARS epidemic hit the Hong Kong city, which had an impact on economy, money and people. After 2003, changes have been made, and the time period from 2005-2012, was the time of urban transformation of the Hong Kong city.

Hong Kong's public transport system is very efficient, which makes normal life in Hong Kong very comfortable, offering many various transport solutions like networks of trams, buses, ferries, subway and train systems, and highly convenient taxi service. MTR Corporation (MTRC) mostly runs the whole public transportation and subway system in Hong Kong. After privatization in 2001, MTR Corporation became one of the major property developers, offering various programs from shopping malls, living complexes and new expanding of subway lines and public transport networks, always involving public opinion and local communities in their developments.[101]

In the last 15 years, series of new developments have been introduced and realized in Hong Kong. Some of those projects are regarded as the new typologies, like the commercial shopping malls that are directly connected to the mass transportation stations. Design office, Jerde Design, created a few significant mix-function projects such as the Langham Place (2005) and the Megabox (2007) that made a positive impact on the urban surroundings. The Urban Renewal Authority (URA) supported several commercial projects, including K11 (2009), iSQUARE (2009), and Hysan Place (2007).

As one of the major developers, MTR Corporation has projected new commercial estates around the stations and connection points. In the

101 Vgl. Tieben, 2013, 46.

public eye, some of these developments raise suspicion because there is a concern that the estates violate Hong Kong's building regulations creating wall effect, which in turn is affecting the fresh airflow inside of the urban areas.

The new infrastructure projects established Hong Kong as a key player in the financial world. By improving its Chek Lap Kok Airport and developing the airport express and highway that are directly connected to the city, financial icons like International Finance Center (IFC) and International Commerce Centre (ICC) have been easily reached by the business clientele, helping to shape Hong Kong as an international business and commercial center.

[Fig.97] **Hong Kong Central District**
1.Bank of China, 2001
2.HSBC, 1985
3.Bank Of America, 1975
4.IFC, International Finance Centre, 2003

10 Things that have shaped Hong Kong city in the last 10 years [102]:

2003 **Sars Epidemic**

2003 **Individual visit scheme**
The Chinese Central Government implemented plan to recover Hong Kong tourism after SARS epidemic with Mainland Chinese tourists

2007 **Demolition of heritage sites**

2008-2009 **Hong Kong & Shenzhen Bi-City Biennale of Urbanism/ Architecture**

2009 **"Conserving Central" scheme**
It is a government preservation program for the old buildings in the Central District

2008-2011 **Urban renewal Strategy review**
Project from The Urban Renewal Authority (URA) and the Secretary of Development had a goal to review the city's renewal strategies ("Envisioning", "Public Engagement" and "Consensus Building"). In 2011 "New Urban Renewal Strategy" was published.

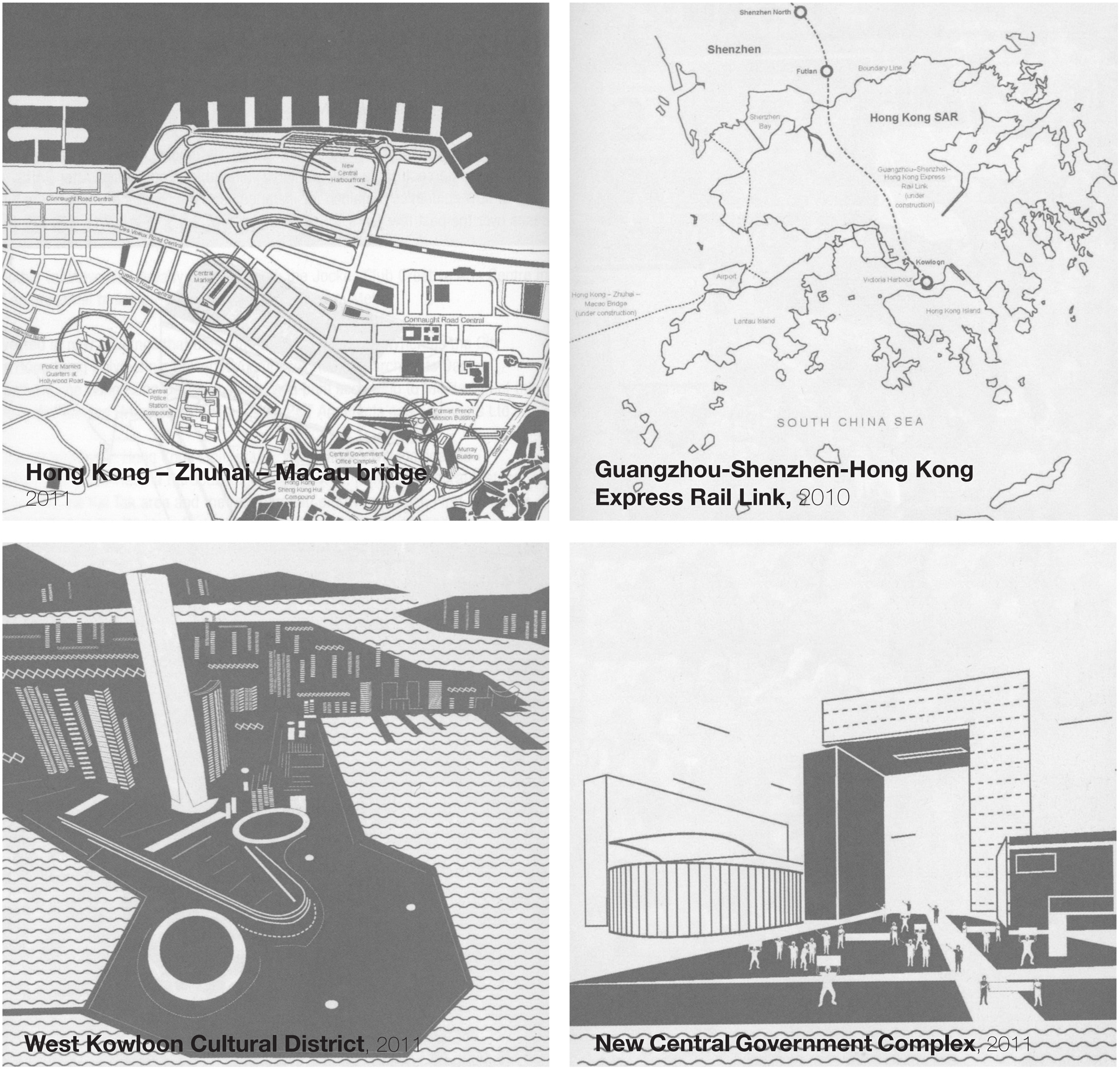
2010 **Guangzhou-Shenzhen-Hong Kong Express Rail Link** (under construction)

2011 **Hong Kong – Zhuhai – Macau bridge** (under construction)

2011 **West Kowloon Cultural District**
Three stage competition with public debate. 'Foster Partners' masterplan was chosen, but development is on due because of financial limitations and lack of public support.

2011 **Inauguration of the New Central Government Complex**
The building complex designed by Rocco Yim at the Tamar site, new reclamation zone in Central District

102 Tieben, 2013, 53.



Hong Kong – Zhuhai – Macau bridge, 2011

Guangzhou-Shenzhen-Hong Kong Express Rail Link, 2010

West Kowloon Cultural District, 2011

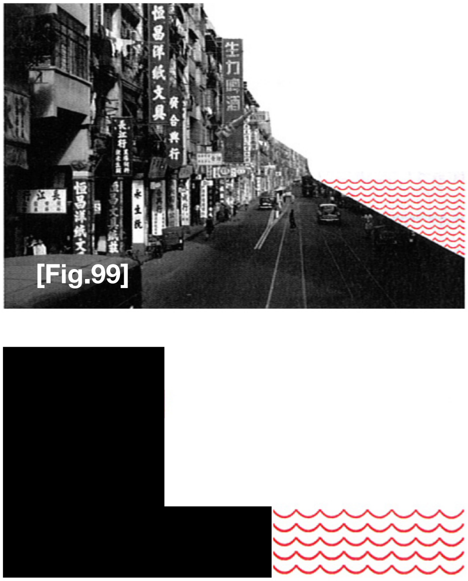
New Central Government Complex, 2011

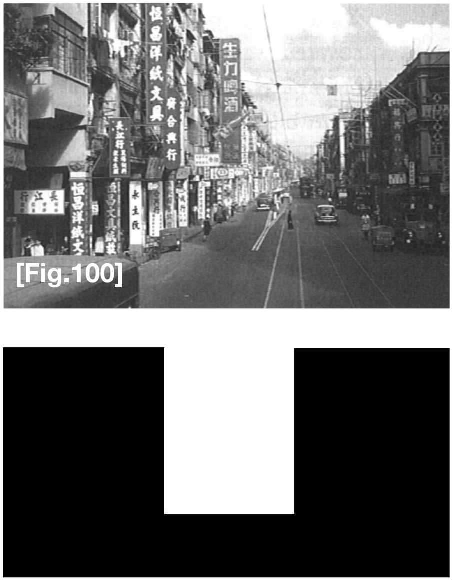
[Fig.98] **Urban Transformation of Hong Kong,** graphics by Mika Savela

Reclamation of Hong Kong

Control over the land was a main instrument for Colony's economy under the British crown, although with limited and small land resources. Government had a hold on ownership and control of the land leases and sale of the land development rights. This model remains presently, and it has been consistent and effective like no other government model in the modern world. Later on, this framework was used for land construction and reclamation, and from the very beginning, it has been leased to developers along with marine spaces. From the period between 1887 and 2006, 67km2 of the sea area has been reclaimed. One-third of the Kowloon peninsula is now settled on the reclamation land. The 35% of developed land in Hong Kong has been taken from the sea. [103]

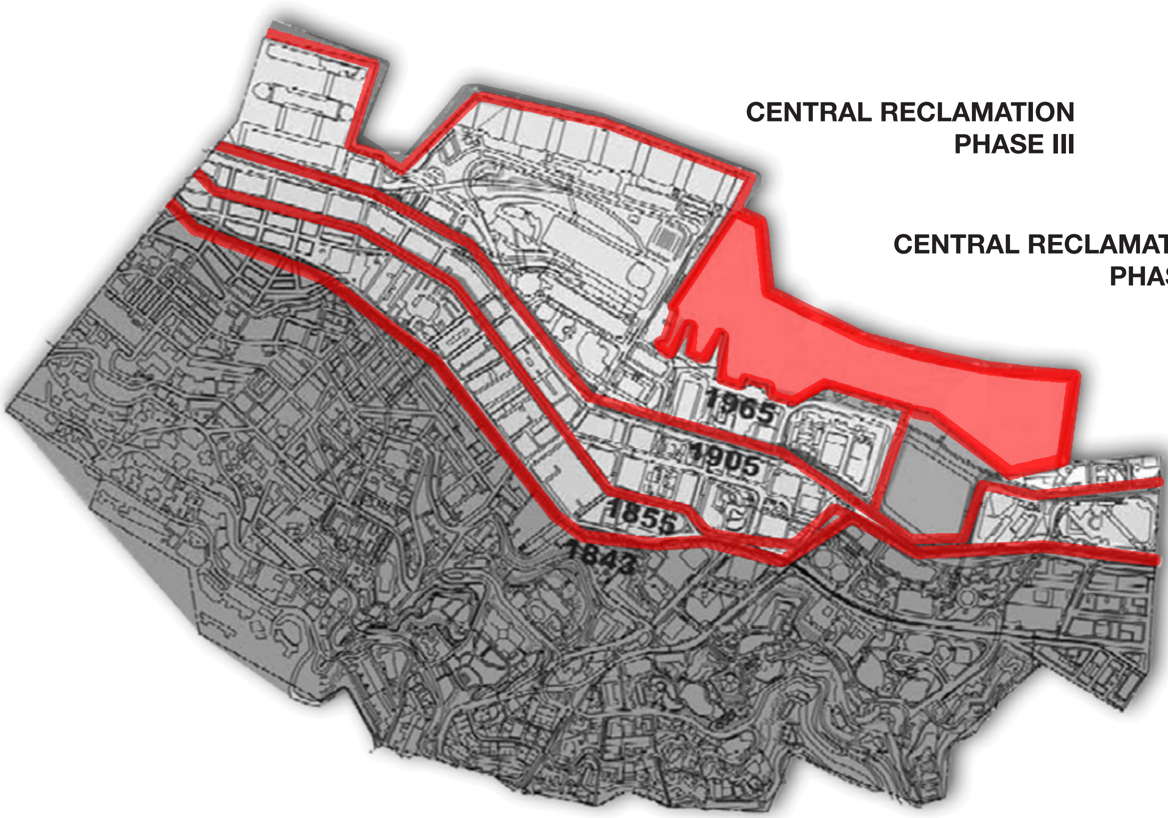
103 Vgl. Shelton/Karakiewicz/Kvan: 2011, 3-5.





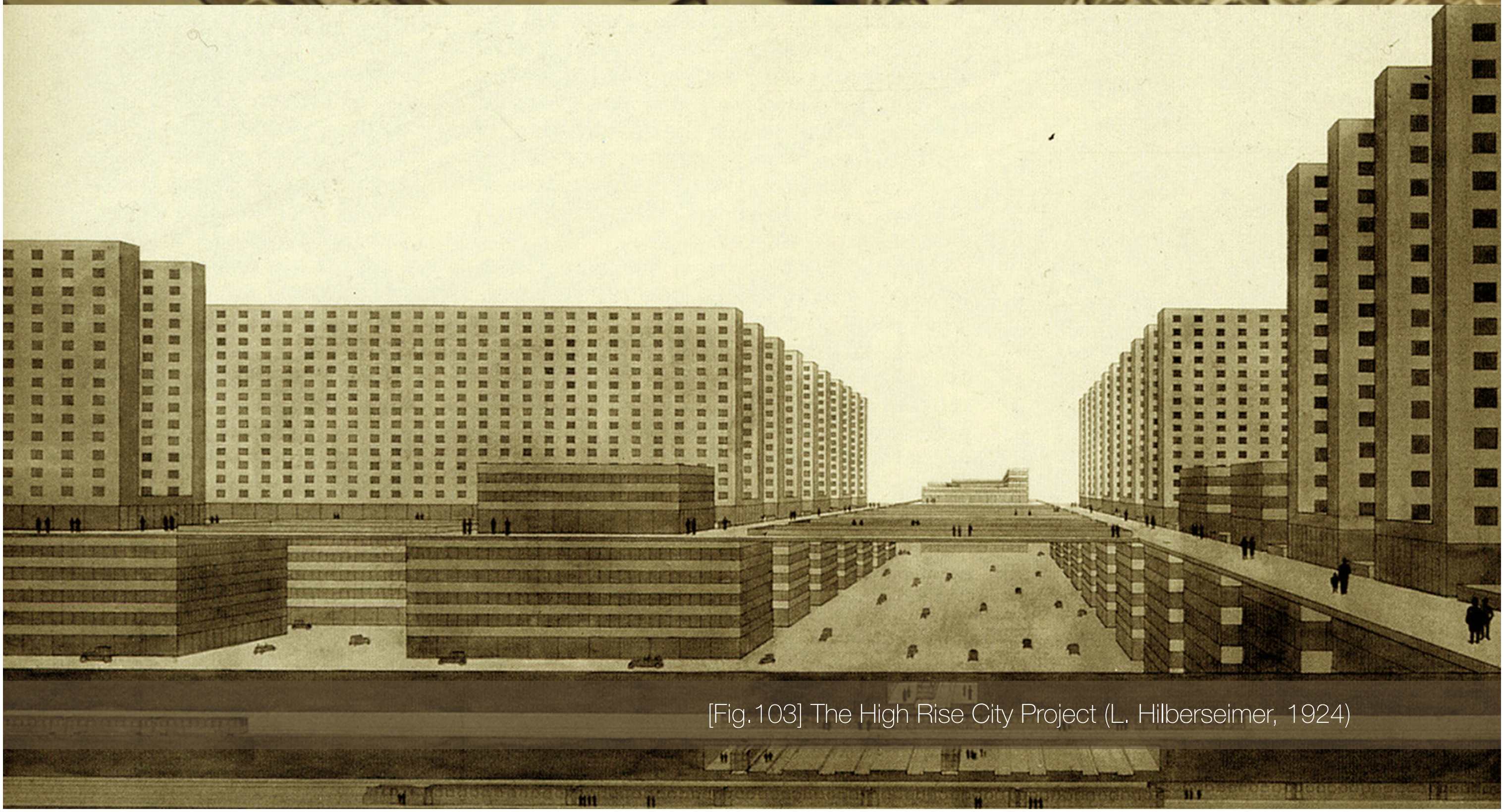
[Fig.99] **Des Voeux once as *Praya*** (term for promenade by the waterfront used in Colonial Hong Kong)

[Fig.100] **Des Voeux Road photo from 50's**, the new street on reclamation land



[Fig.101] **Reclamation starting from 1843-2014**, Central District, Hong Kong

[Fig.102] **Ville Radieuse** (The Radiant City) is an unrealized urban masterplan by Le Corbusier, first presented in 1924 and published in a book of the same name in 1933



[Fig.103] The High Rise City Project (L. Hilberseimer, 1924)

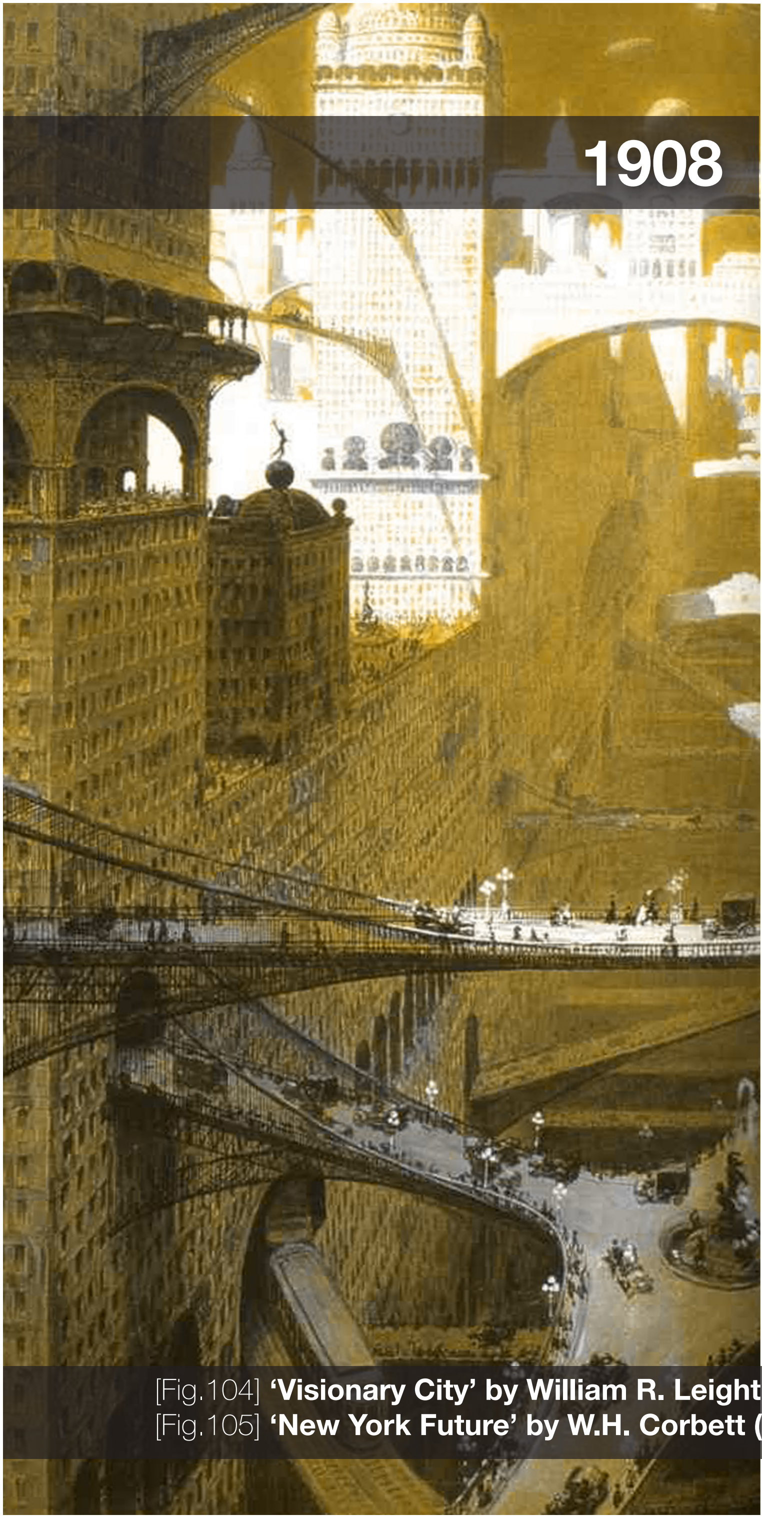
"Hong Kong – the Utopia City"[104]

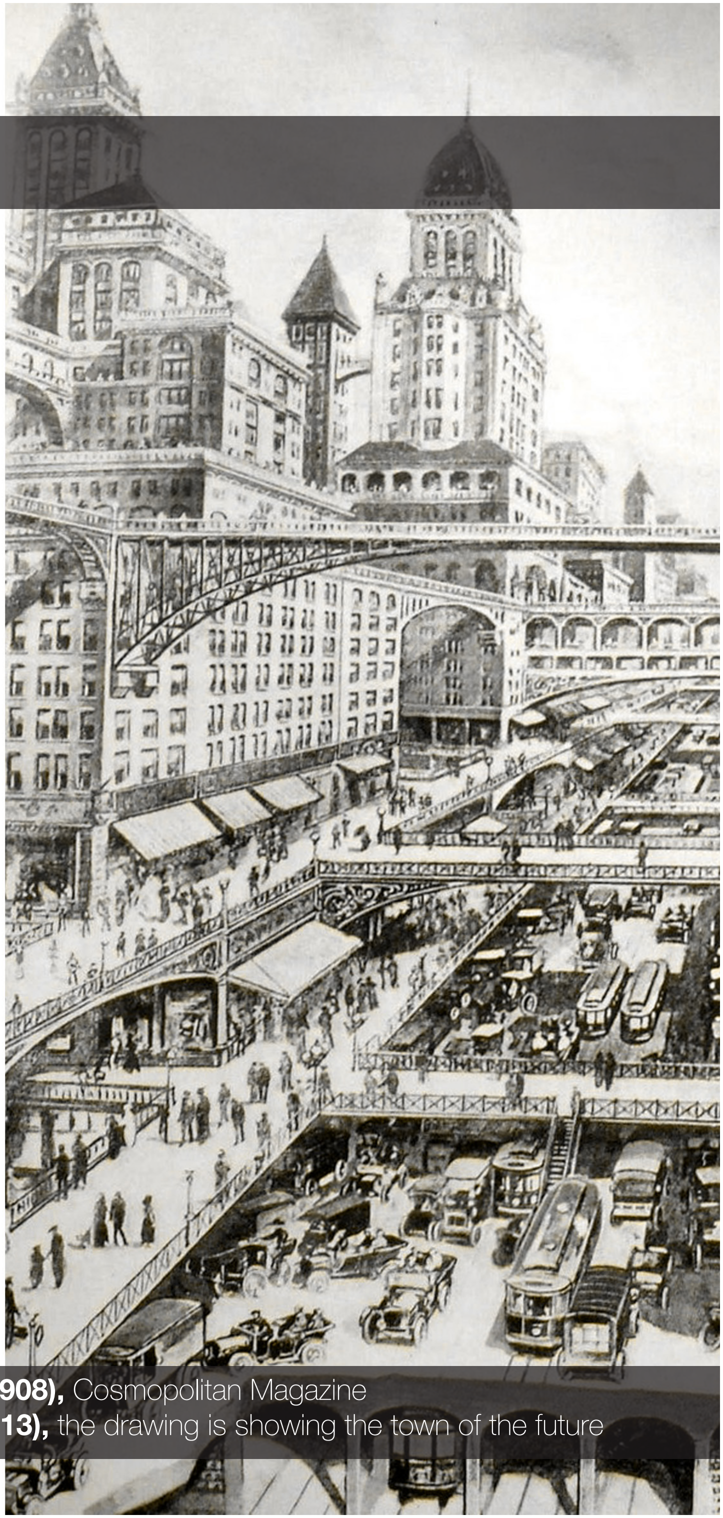
The utopian vision and the solution of a future city and high density living were common and popular ideas in the sixties for architects around the world, ranging from Buckminster Fuller's Floating City, Peter Cook's Plug-in City, Ron Herron's Walking City, to many others. Those ideas stayed unaccomplished, but development of Hong Kong was highly influenced with many of them. The vision of Radiant City (Ville Radieuse presented in 1924) that Le Corbusier made for Paris stayed utopian, but the elements of that master plan can be recognized in many developments in the Hong Kong city.[105]

The idea of urban blocks connected with bridges and podia, hugely developed in Hong Kong. In 1924 Ludwig Hilbersheimer introduced a 'vertical city' of street block podia and high slab-block, where the ground level was for traffic usage, and the podia-based on the sixth level above-was connected with the series of pedestrian bridges. Podium as an urban form strongly overtook Hong Kong and developed in the pragmatic way, where some followed the modern utopian models and theory, but not intentionally derived from them. In this evolution of podium few types can be recognized in the Hong Kong's example.[106]

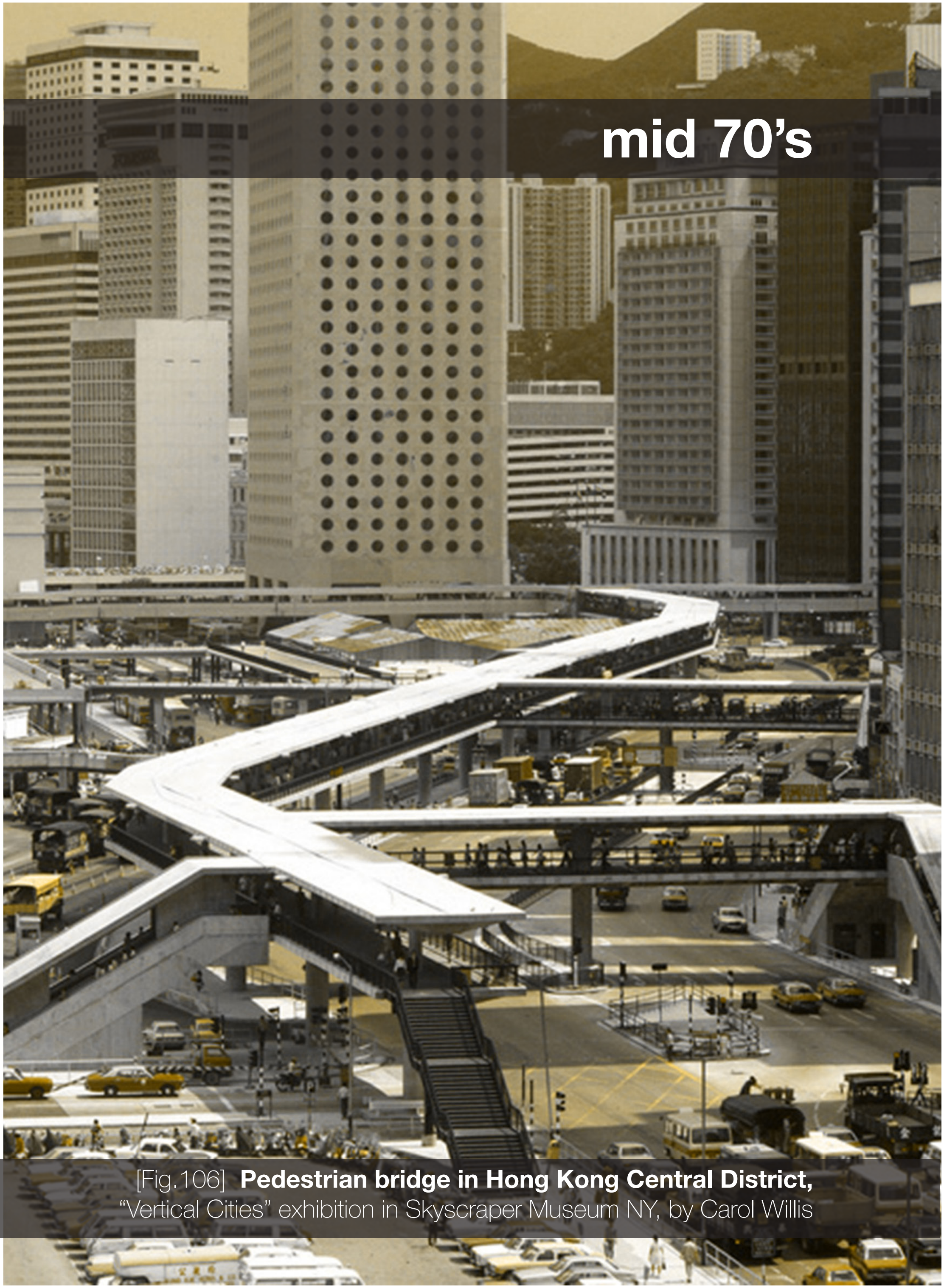
104 Lau, 1999, 1.
105 Vgl. Lau, 1999, 1.
106 Vgl. Shelton/Karakiewicz/Kvan, 2011, 112.

1908





[Fig.104] **‘Visionary City’ by William R. Leight (1908),** Cosmopolitan Magazine
[Fig.105] **‘New York Future’ by W.H. Corbett (1913),** the drawing is showing the town of the future



[Fig.106] **Pedestrian bridge in Hong Kong Central District,**
"Vertical Cities" exhibition in Skyscraper Museum NY, by Carol Willis

_transport

[Fig.107] **The View from West Kowloon,** looking over Victoria Harbour and Central

The compact urban footprint is followed by very organized public transport network. The transport system offers diversity services, which includes trains, subway, double-decker buses, mini buses, ferryboats, taxis, trams, helicopters, bicycles, cable cars, escalators and more. Traveling in the city is very convenient, as 90% of it is being done by the public transportation systems. The result is very low percentage of registered vehicle owners.

According to Hong Kong's Transport Department data, the number of registered private cars reached 464,595 in June 2013. By 2017, predictions are to have almost 540,000, estimated by the Environment Bureau.

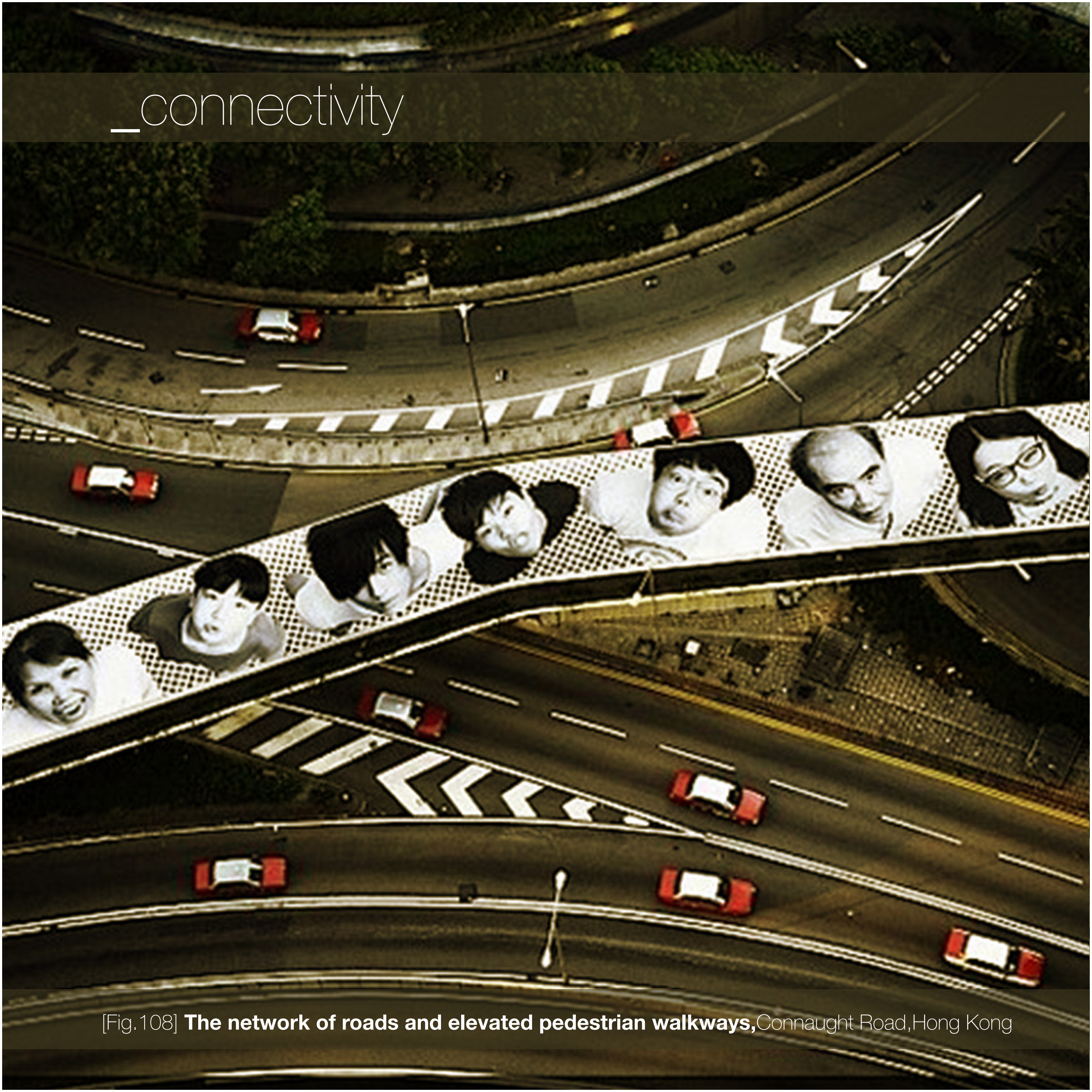
According to the department figures, the trend of private car ownership is increasing. In the last seven years, the private car ownership increased to 100,000 more. Up until 2007, it took 14 years for the number to grow from 300,000 to more than 400,000 owners. [107]

The University of Hong Kong's economics professor Timothy Hau Doe-kwong, points out that Hong Kong's private cars ownership is very low compared with the other developed cities. For instance, in Singapore, there are 100 cars per 1,000 people, in London, the number reaches 300 cars, and in Hong Kong, the figure is 63 cars per 1,000 people. [108]

According to analyst Jeff Kenworthy, the model of Hong Kong's transit system and tremendously small car usage, should be applied to everywhere in the world. In his paper "Model Cities: Asia" he has noted that half of the Hong Kong's residents live within 500 m of the Mass Transit Rail station.[109]

107 Vgl. Chi-fai, 2013
108 Vgl. Chi-fai, 2013
109 Vgl. Shelton/Karakiewicz/Kvan: 2011, 06.

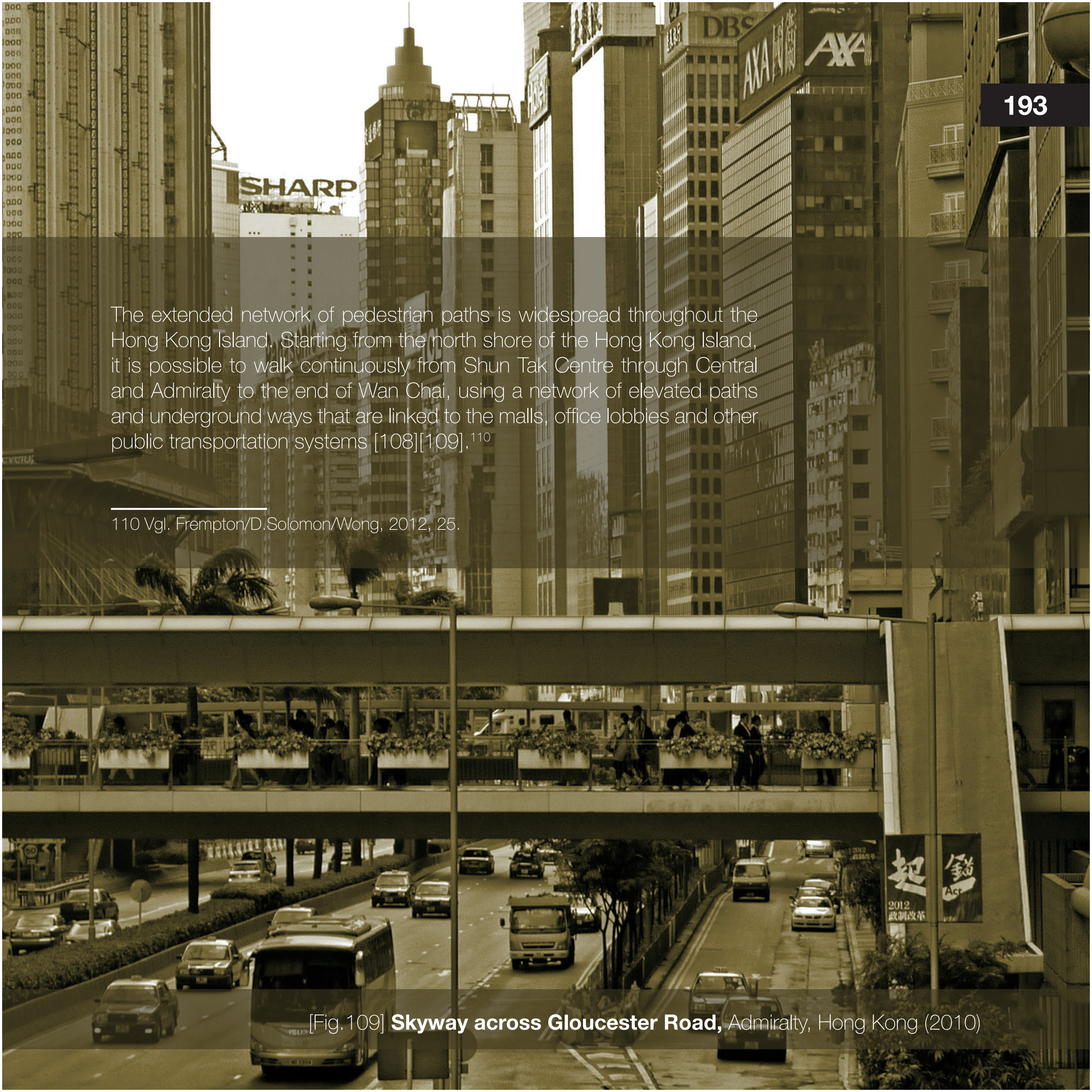
_connectivity



[Fig.108] **The network of roads and elevated pedestrian walkways,**Connaught Road,Hong Kong

The extended network of pedestrian paths is widespread throughout the Hong Kong Island. Starting from the north shore of the Hong Kong Island, it is possible to walk continuously from Shun Tak Centre through Central and Admiralty to the end of Wan Chai, using a network of elevated paths and underground ways that are linked to the malls, office lobbies and other public transportation systems [108][109].[110]

110 Vgl. Frempton/D.Solomon/Wong, 2012, 25.



[Fig.109] **Skyway across Gloucester Road,** Admiralty, Hong Kong (2010)

_connectivity

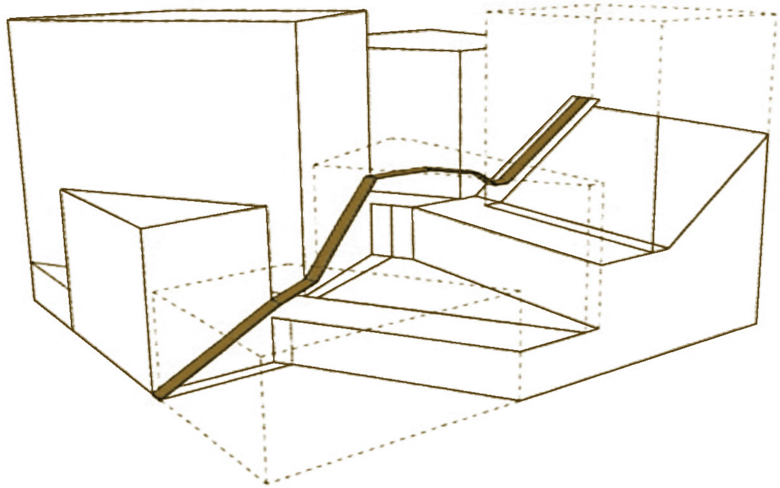
[Fig.110] **The Central-Mid-Levels Escalators** (2008)

“Data reported for 1998 suggests that Hong Kong has the largest number of escalators per capita in the world, with one escalator for every 1,242 people.”[111]

Central to Mid Levels Escalator, are connecting eighteen escalators and three autowalks with covered walkways and staircases in a distance of 800m, where network climbs up to 135m. Data from 2008 shows that 81,000 people per day are using this network.[112]

Elevated Mid Levels are connected with Central Waterfront trough network of escalators moving through the streets and buildings [33].

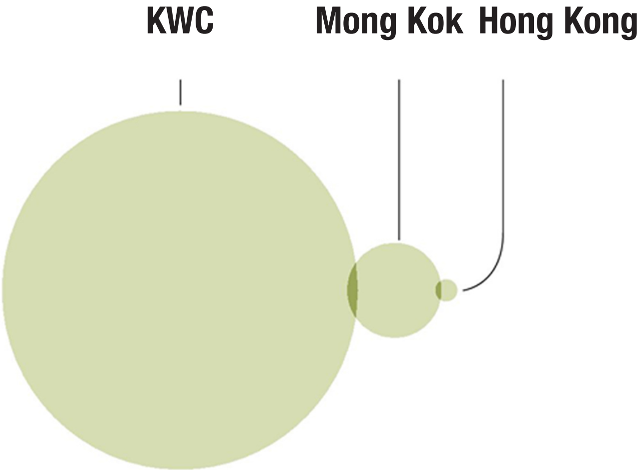
111 Shelton/Karakiewicz/Kvan: 2011, 06.
112 Vgl. Shelton/Karakiewicz/Kvan: 2011, 138.



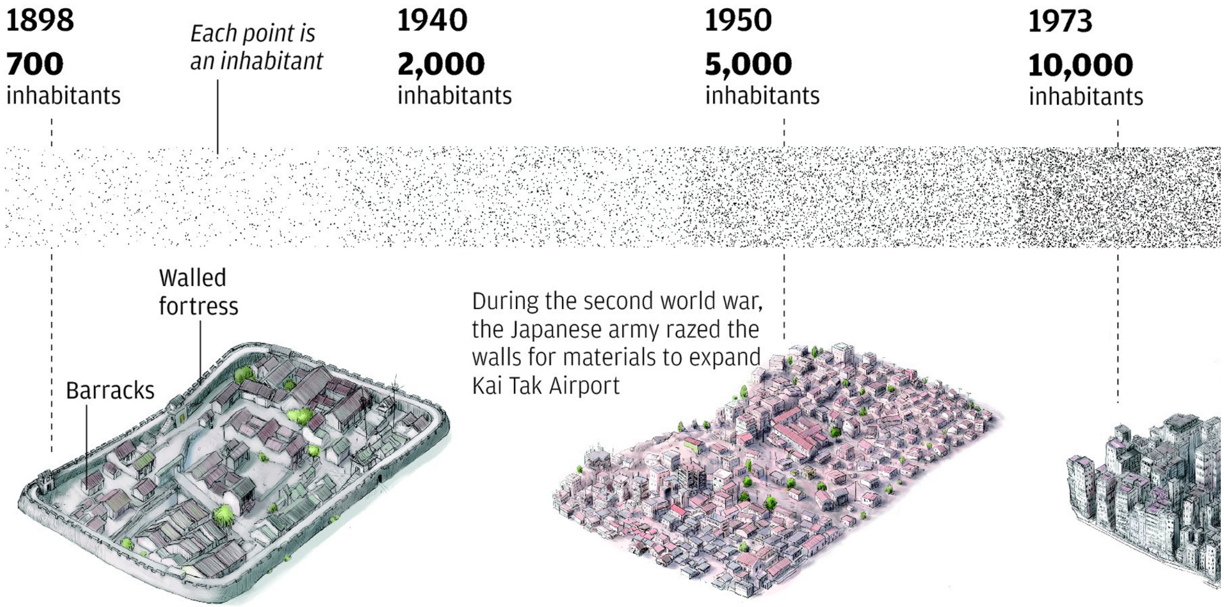
[Fig.111] **The Central-Mid-Levels Escalators** scheme

kowloon wall city

the city of anarchy



[Fig.112] **Populations density** per square kilometer

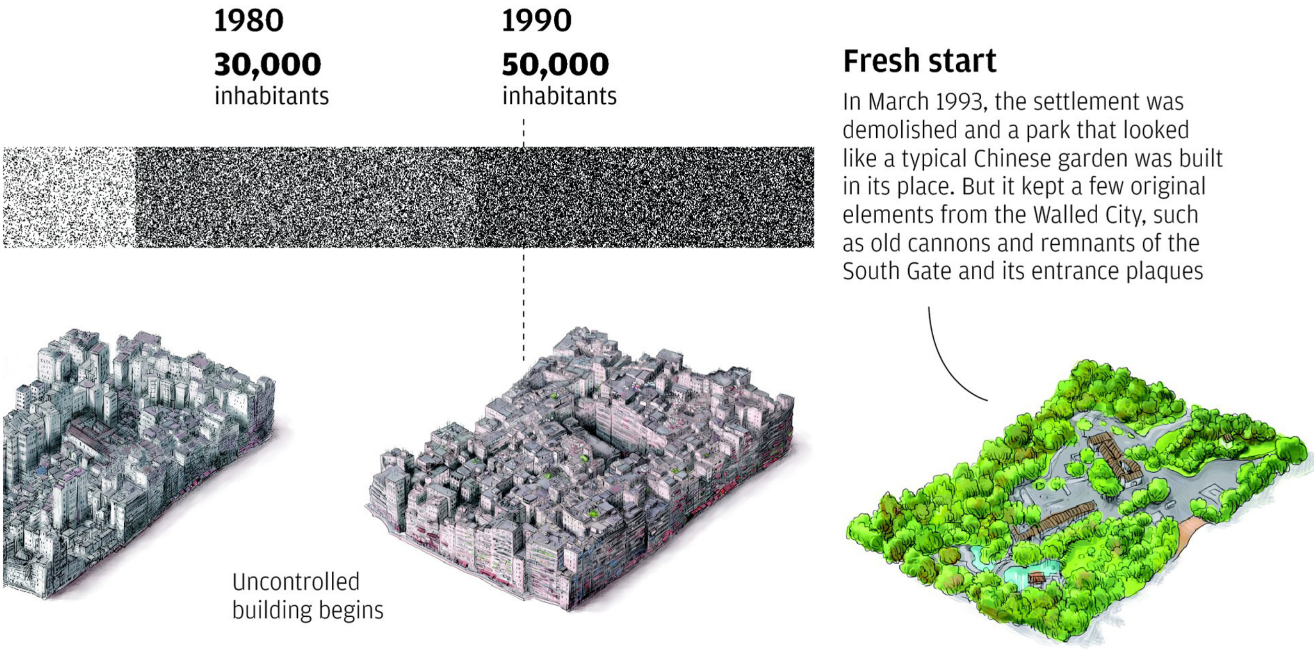


Built in a Sung Dynasty (960-1297 CE) for oversea salt trade, once a small wall fort, Kowloon Wall City has a long history. In 1841, the British settled on the Hong Kong Island, just across the canal, the small wall fort become very important strategic point for monitoring the new land users. Therefore, Chinese rulers rebuilt the fort in 1847, in order to accommodate 150 soldiers and officers, creating new massive wall fort.

In August 1898, the British expanded further on the northland of the Kowloon Peninsula, taking the area of New Territories. By then, the Wall City was already full of illegal dealings, such as opium, gambling and prostitution. The Wall City stayed under the Chinese territory, as well as access to the shore. In 1899, the British took the Wall City from the Chinese rule and ignored this piece of land.

During the Second Word War, the Japanese occupied Hong Kong. In order to build new airport runaway, the Japanese soldiers demolished stonewall

[Fig.113] **Dramatic Transformation** from fortress to park



[Fig.114] **The Kowloon Wall City during the night in 1993**

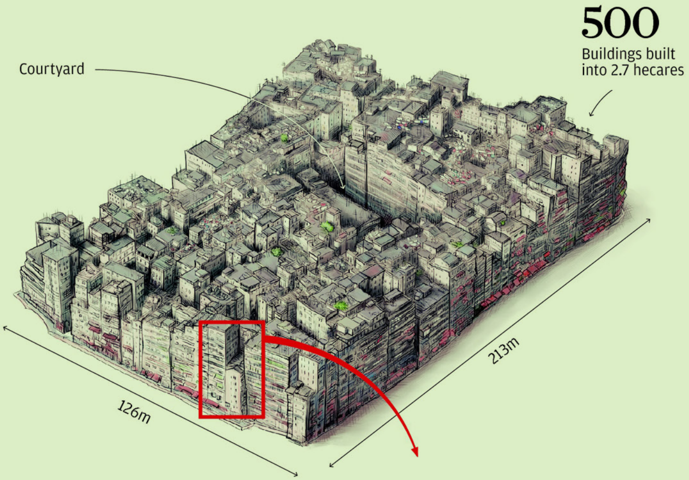
[Fig.115] **The Kowloon Wall City street shops and balconies** structure of the old fort. By 1947, over 2,000 squatters lived in the Wall City area. After the riots against the British Imperial out in Canton and Shanghai, the British decided to ignore the whole aria once again. Short after, the Wall City accommodated many Chinese refugees, and became well known for its own inside illegal actions such as prostitution, gambling and drug dealing.

On an area of 2.6 hectares, or 121x213m, in the mid-1980s, 35,000 people lived in twelve to fourteen story structures. Simply described, it was a city inside the city. All urban services were available, from power, water, health services, schools, religious areas, shopping areas, and jobs. Many other activities were provided inside of those structures, such as textile manufacture, toys, food, and etc.[113]

The Kowloon Wall City had developed infrastructure system, stationed wherever possible. In order to provide water for all users, 77 water wells were pumping the water to the rooftops and based on gravity principle the water was supplied elsewhere. The residents needed to pay to those who owned the water pipes. Electricity was taken from the city's network, illegally. After the fire in the 1970s, this illegality was regulated. Inorganic waste storage was on the roof, the only free space in the entire complex.
In 1997, the British gave back the territories to China, and status of the Wall City was finally solved. In January 1987, because of the safety and health reasons, Kowloon Wall City was totally demolished. It is estimated that 8,800 apartments and 1,045 retail shops were inside of the Kowloon Wall City at the time of demolition. [114]

Kowloon Wall City is a great example of truly 3D volumetric, impressive mega-structure, great intensive mixed use, flexibility and transformation. The heights were limited to 45m because of the close distance to Kai Tak airport. Without this restriction, the structure and volumetric would be more innovative for sure.

113 Vgl. Shelton/Karakiewicz/Kvan: 2011, 29.
114 Vgl. Smart, 2006 zit. n. Shelton/Karakiewicz/Kvan: 2011, 29



1 There were 77 wells inside the city some 90 metres deep. Electric pumps delivered water to big tanks on rooftops. From there, water was funnelled through narrow pipes to the homes

2 Electric wires were placed outdoors to prevent fires

3 The street-level shops were a mix of unlicensed dentists and doctors, market stalls and cafes that often included dog on the menu. Fish balls, barbecued and roast meat and other foodstuffs were manufactured in premises with little or no sanitation

4 Brothels and gambling dens operated with impunity

5 Residents carried umbrellas to shield themselves from constantly dripping water pipes above the narrow alleys

6 Without municipal services, there was no rubbish collection. Old television sets, broken furniture, discarded mattresses and other bulky items were hauled to the roof and abandoned

7 Other rooftops were used for exercise, playgrounds, relaxing and even pigeon racing

8 Authorities installed eight freshwater standpipes – one inside the city, and the others outside its perimeter

9 There were many heroin dealers but they were untouchable. Police could only arrest non-residents

10 Tiny metal fabrication shops made up a good number of the 700 or so industrial premises. Most were found between the ground and fifth floors

11 There were several schools and kindergartens, some of them run by organisations such as the Salvation Army

[Fig.116] **The Kowloon Wall City** Cross Section

Despite its daunting, squalid appearance and reputation for lawlessness, many of Kowloon Walled City's former residents remember it fondly. It may have been the City of Darkness to outsiders, but to thousands who called it home, it was a friendly, tight-knit community that was poor but generally happy

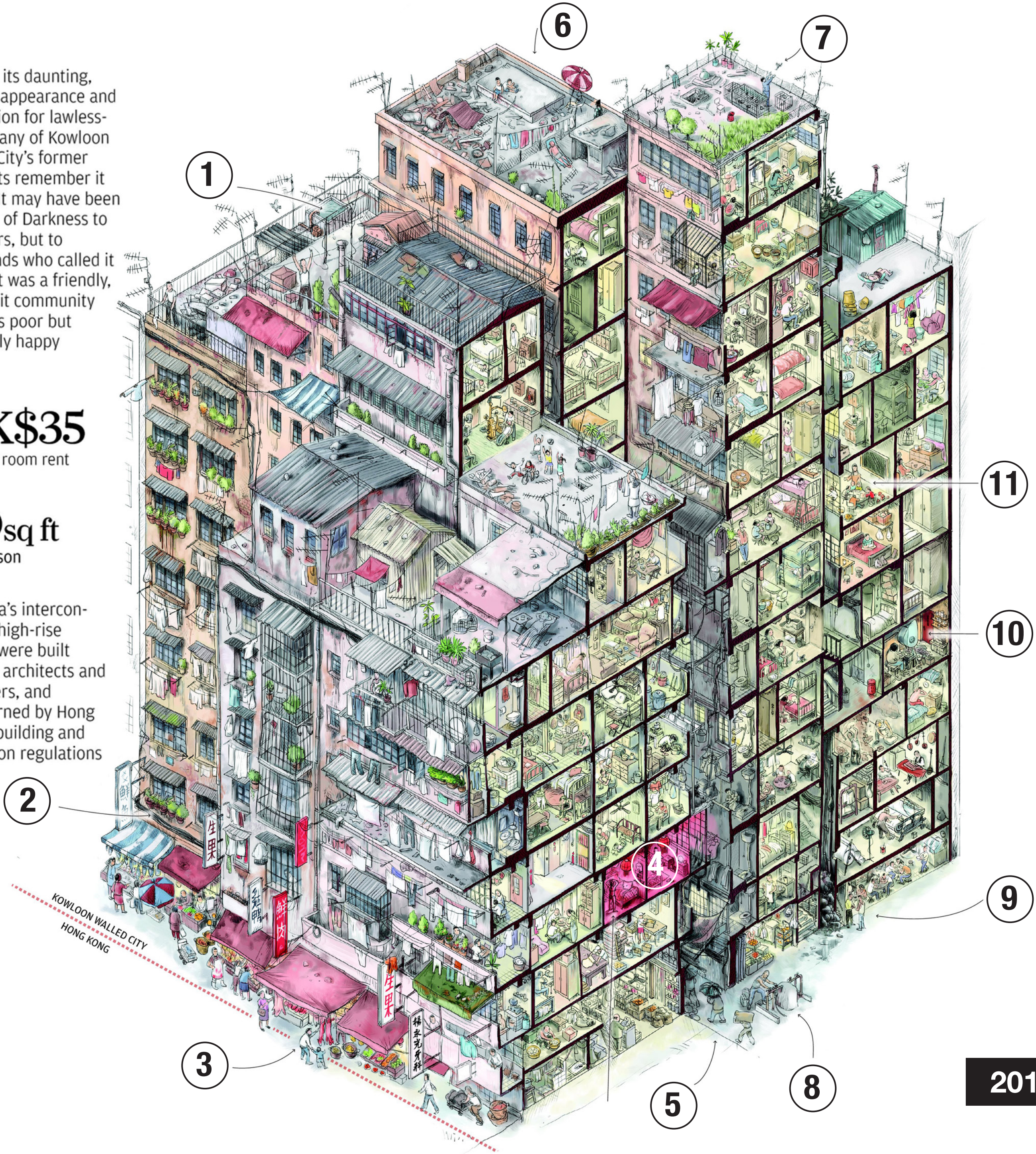
HK$35

monthly room rent

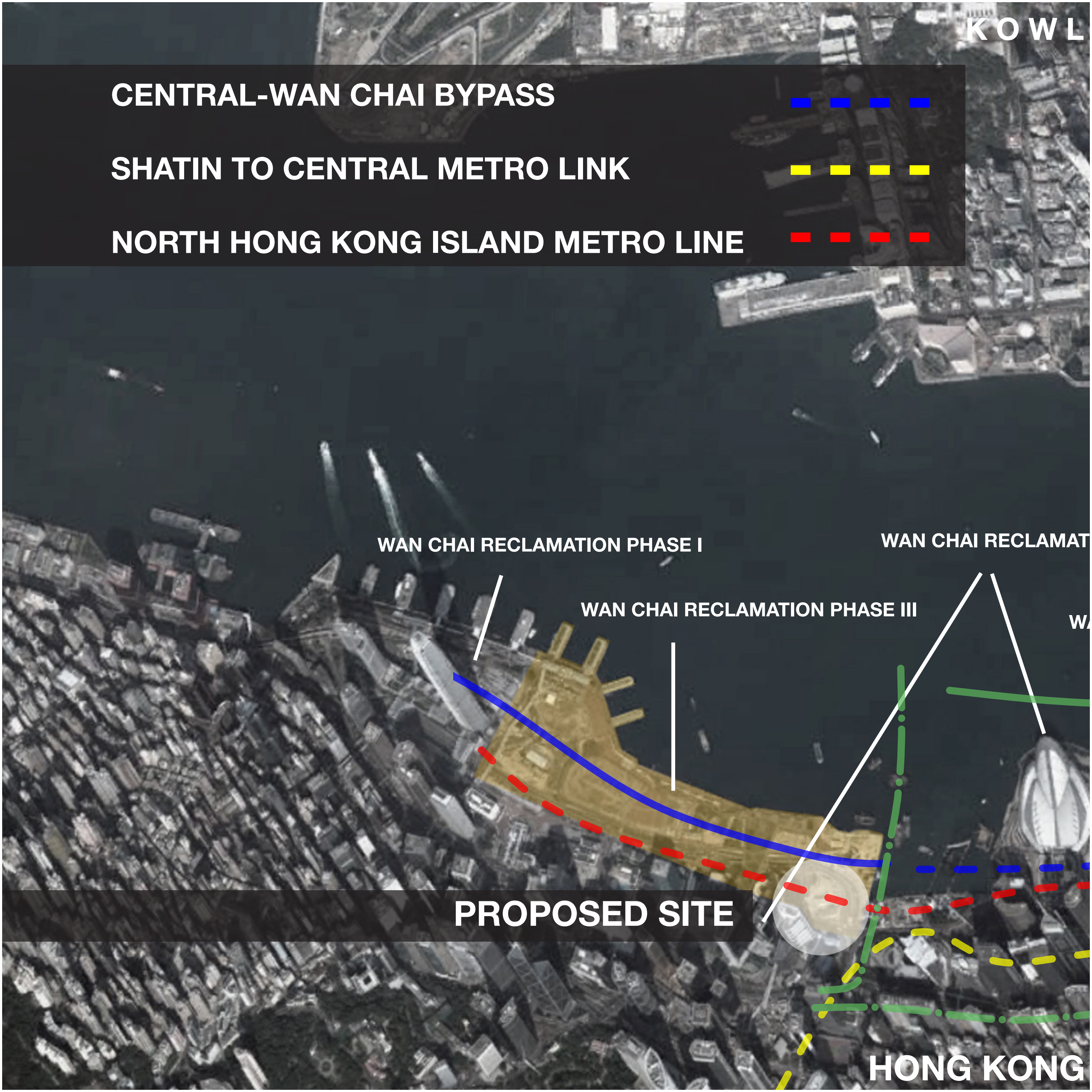
40sq ft

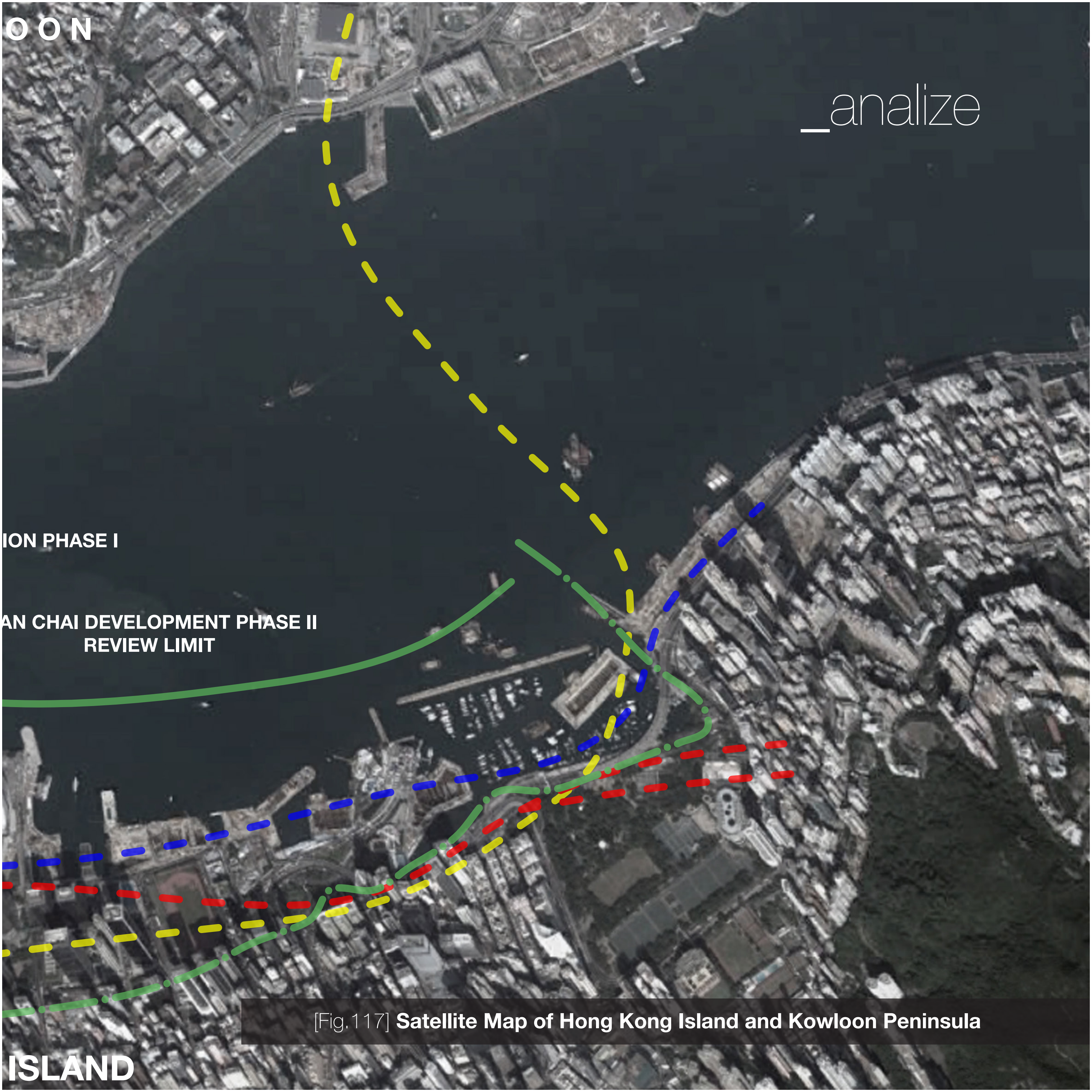
per person

The area's interconnected high-rise towers were built without architects and engineers, and ungoverned by Hong Kong's building and sanitation regulations

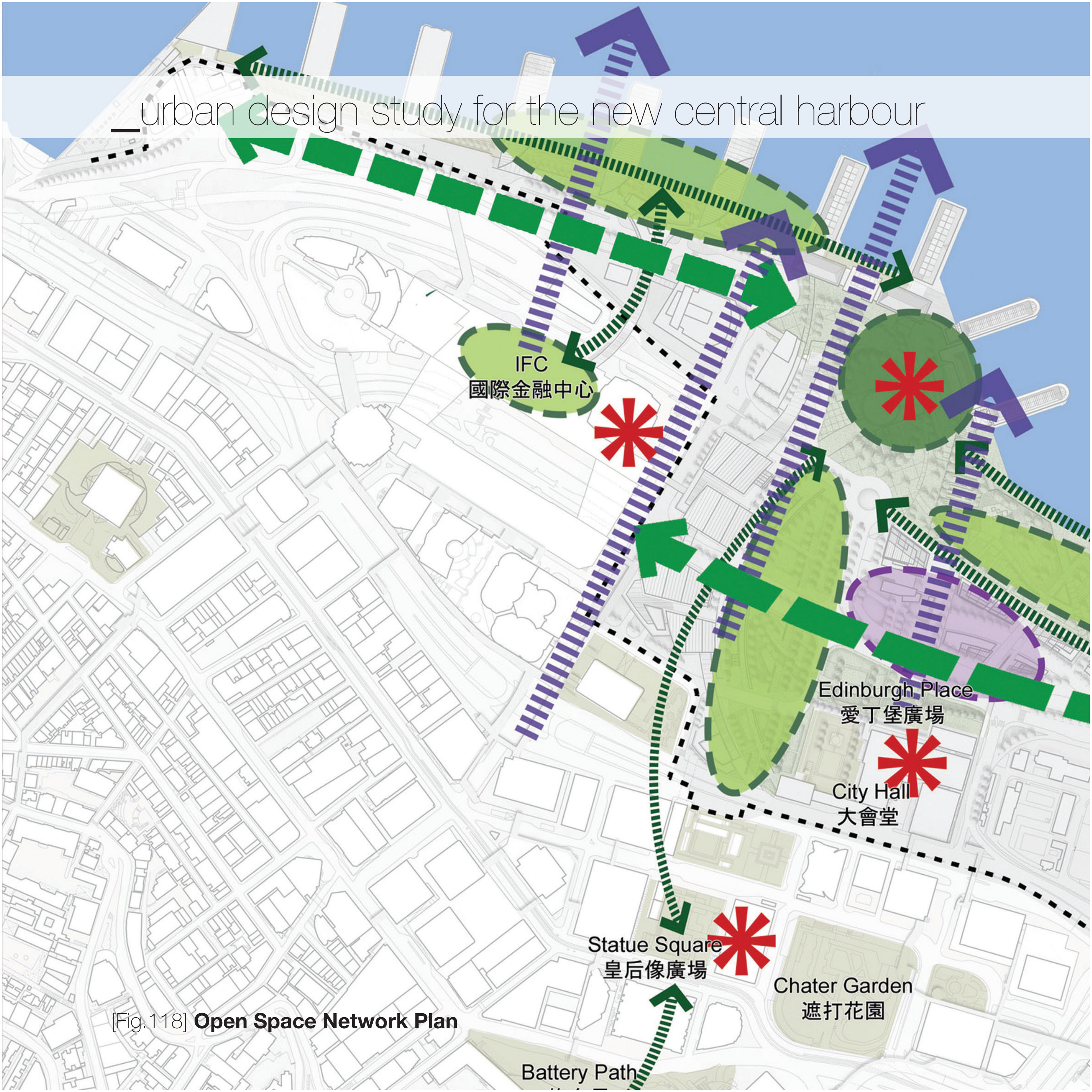


project


KOWL
CENTRAL-WAN CHAI BYPASS
SHATIN TO CENTRAL METRO LINK
NORTH HONG KONG ISLAND METRO LINE
WAN CHAI RECLAMATION PHASE I
WAN CHAI RECLAMAT
WAN CHAI RECLAMATION PHASE III
PROPOSED SITE
HONG KONG



[Fig.117] **Satellite Map of Hong Kong Island and Kowloon Peninsula**



[Fig.118] **Open Space Network Plan**


Legend 圖例
Tree-lined Boulevard 林蔭大道
Major Public Facilities 主要公共設施
Major Activity Nodes 主要活動匯聚點
Primary Open Space 主要休憩用地
Secondary Open Space 次要休憩用地
Green Space 綠化區域
Major Landmark / Focal Point 主要地標/核心地點
Green Connector 連接的綠化園地
View Corridor 主要觀景廊
Study Area 研究範圍
Grand Bauhinia Plaza
金紫荊廣場
HKCEC
香港會議展覽中心
PROPOSED SITE
Central Government Complex and
Legislative Council Complex
政府總部及立法會大樓
HK Arts Centre
香港藝術中心
HKAPA
香港演藝學院


天星碼頭
Star Ferry Pier
中環-灣仔繞道
Central - Wanchai Bypass
國金二期
IFC II
國金一期
IFC I
P1路
Road P1
P2路
Road P2
大會堂
City Hall
干諾道中 Connaught Road Central
Statue Square
皇后像廣場
Chater Garden
遮打花園
LEGEND 圖例
1. Retail over the Pier 碼頭上蓋之零售商店
2. Elevated Covered Walkway 高架行人走廊
3. Hotel 酒店
4. Office with Retail below 辦公室大樓及低層零售商店
5. Landscaped Podium with Retail below 園景平台及低層零售商店
6. Sculpture Plaza 雕塑廣場
7. Ferry Plaza 渡輪廣場
8. Old Star Ferry Clock Tower and Gallery 舊天星鐘樓及展覽館
9. Re-assembled Queen's Pier 重組的皇后碼頭
10. Landscaped Open Space at Grade 地面園林休憩用地
11. Retail 零售商店
12. Waterfront-related Commercial and Leisure Use
13. Water Feature 水景
14. Flat Lawn 草坪
15. Featured Piazza 特色廣場
16. Undulating Lawn 起伏有致的草坪
17. Viewing Platform 觀景台
18. Floating Market 水上市場
19. Boardwalk 木板步行徑
20. PLA Berth 解放軍軍事碼頭
21. Military Access 軍用通道
22. Ventilation Shaft 通風塔
23. Electricity Supply Station 電力供應站
24. Harbourfront Promenade 海濱長廊
25. Waterfront Event Plaza 海濱活動廣場
26. Waterfront-related Commercial and Leisure Use
27. Landscaped Deck 園景平台
28. GIC Building 政府、機構或社區用途之建築群
29. Outdoor Performance Area 戶外表演場地
30. Hong Kong Academy for Performing Arts Extension
31. Proposed Hong Kong Visual Arts Education Centre
32. Public Landing Steps 公衆登岸梯級
33. Landscaped deck to HKCEC West
34. Edinburgh Place 愛丁堡廣場
35. Civic Square 文娛廣場

_masterplan for the new central harbour

[Fig.119] **Illustrative Master Layoutplan B (2008)**
Aedas - CENTRAL RECLAMATION URBAN DESIGN STUDY 2008

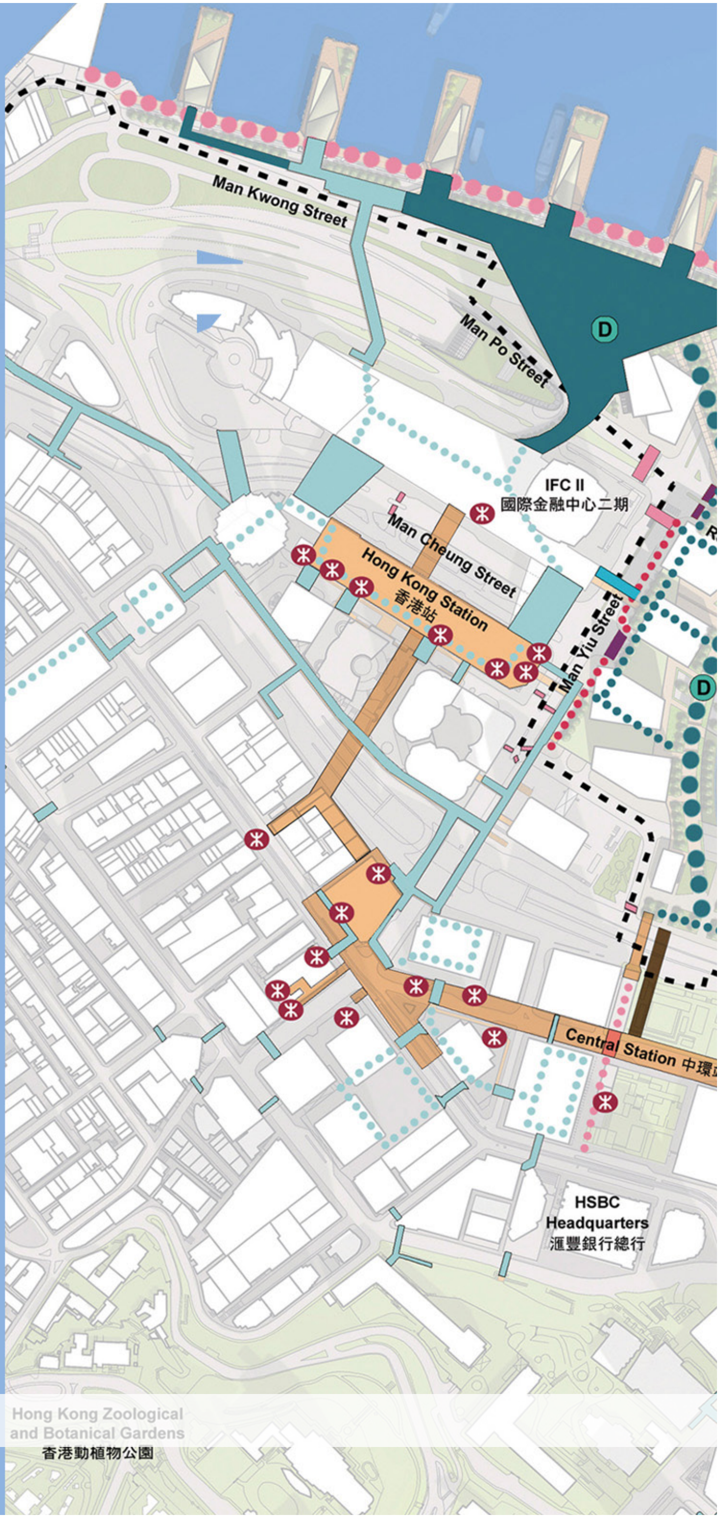
- Existing Pedestrian Footbridge 現有行人天橋
- Existing Elevated Internal Pedestrian Link through a Building 現有的室內行人通道
- Planned Pedestrian Footbridge/ Landscape Deck 已規劃的行人天橋/園景平台
- Potential Pedestrian Footbridge (from other studies) 擬建的行人天橋(參照其他研究報告)
- Potential Pedestrian Footbridge (under study) 擬建的行人天橋(研究中)
- Potential Elevated Internal Pedestrian Link through a Building/Landscape Deck of a Building (under study) 擬建的室內行人通道/園景行人平台(研究中)

- Existing At-Grade Pedestrian Crossing 現有地面行人過路處
- Existing At-Grade Pedestrian Link through a Building/ Park/ Waterfront 現有的地面室內行人通道 (穿過建築物/公園/海濱)
- Planned At-Grade Pedestrian Crossing 已規劃的地面行人過路處
- Proposed At-Grade Pedestrian Crossing 擬建的地面行人過路處
- Potential At-Grade Pedestrian Link through a Building/ Park/ Waterfront 擬建的地面行人過路處 (穿過建築物/公園/海濱)(研究中) (under study)
- Potential At-Grade Pedestrian Crossing (under study)

- D Landscaped Deck 園景平台

- Existing MTR Station/ Underground Pedestrian Link
- Planned MTR Station/ Underground Pedestrian Link
- Potential Underground Pedestrian Link (under study)

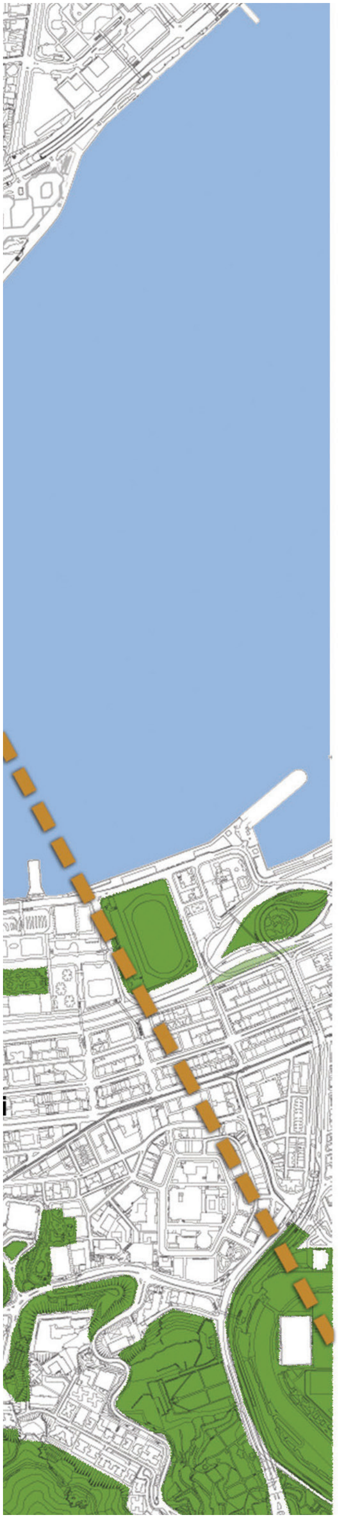
- Study Area 研究範圍
- Proposed Site



[Fig.120] **Pedestrian Network Plan**

_pedestrian circulation

[Fig.121] **View Corridors**



_view corridors

Legend 圖例

Primary Visual Envelope 主要視覺範圍

1. Tsim Sha Tsui Cultural Centre 尖沙咀文化中心
2. Victoria Peak 扯旗山
3. The Peak 山頂
4. Mount Gough 歌賦山
5. Magazine Gap 馬己仙峽
6. Hong Kong Park 香港公園
7. HSBC Headquarters 匯豐銀行總行
8. IFC 國際金融中心
9. HKCEC 香港會議展覽中心
10. Government Headquarters and Legislative Council Building 政府總部及立法會大樓
11. Star Ferry Pier 天星碼頭
12. City Hall 大會堂
13. Pedder Street 畢打街
14. The Hong Kong Academy for Performing Arts (HKAPA) 香港演藝學院

Major View Corridors (VC) 主要觀景廊

VC1: From IFC Podium to the harbour 由國際金融中心平台至海港

VC2: Along Pedder Street and Man Cheung Street to the harbour 沿畢打街和民祥街至海港

VC3: From HSBC Headquarters and Statue Square to the harbour 由匯豐銀行總行及皇后像廣場至海港

VC4: From City Hall to the harbour 由大會堂至海港

VC5: From Tamar site to the harbour 由添馬艦至海港

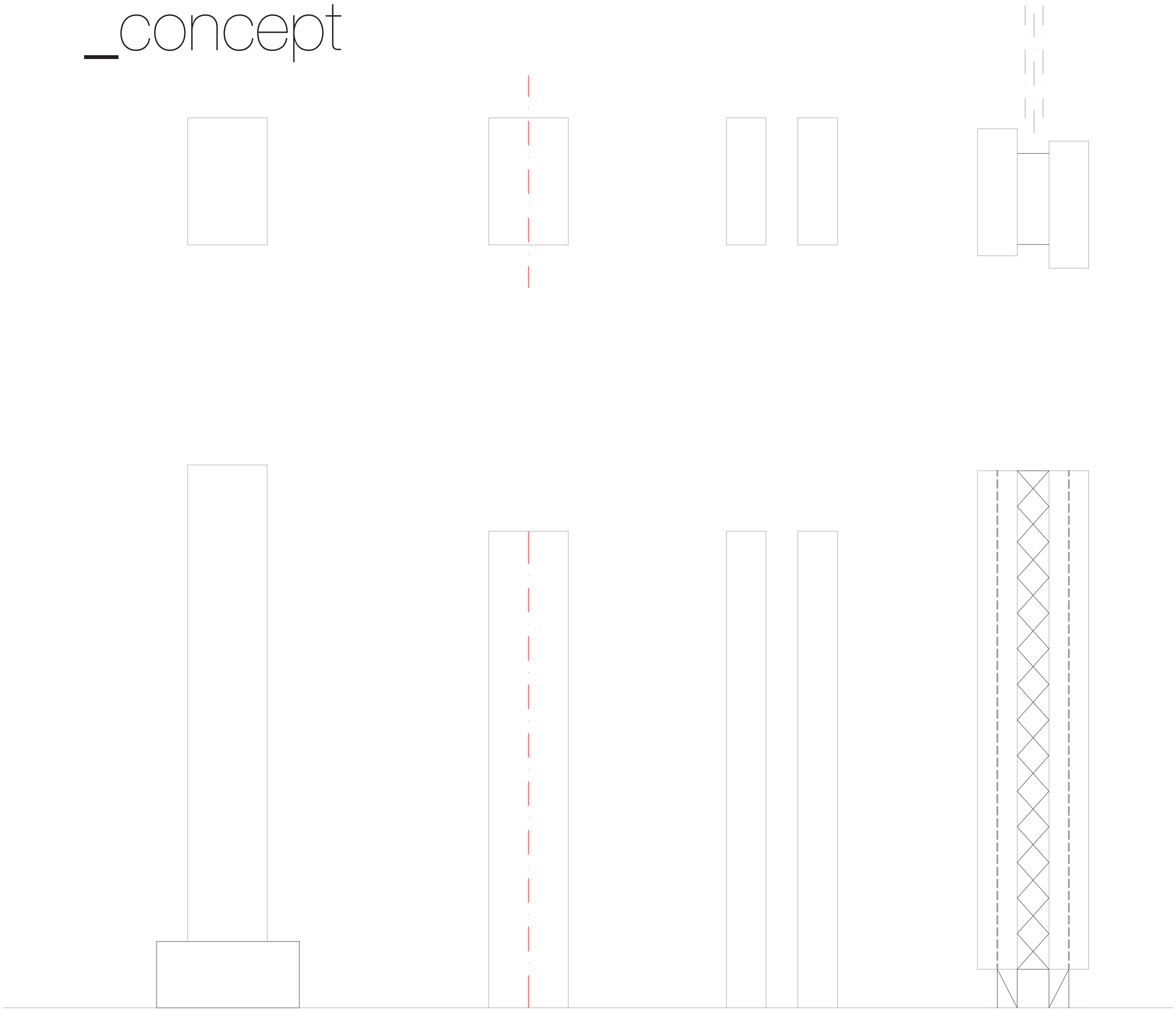
VC6: From the proposed HKAPA Extension to the harbour 由擬建的香港演藝學院擴建部分至海港

Major Ridgeline 主要山脊線

Green areas providing a backdrop to major developments in the study area 綠化的環境構成研究範圍內各主要發展的天然背景

Study Area 研究範圍

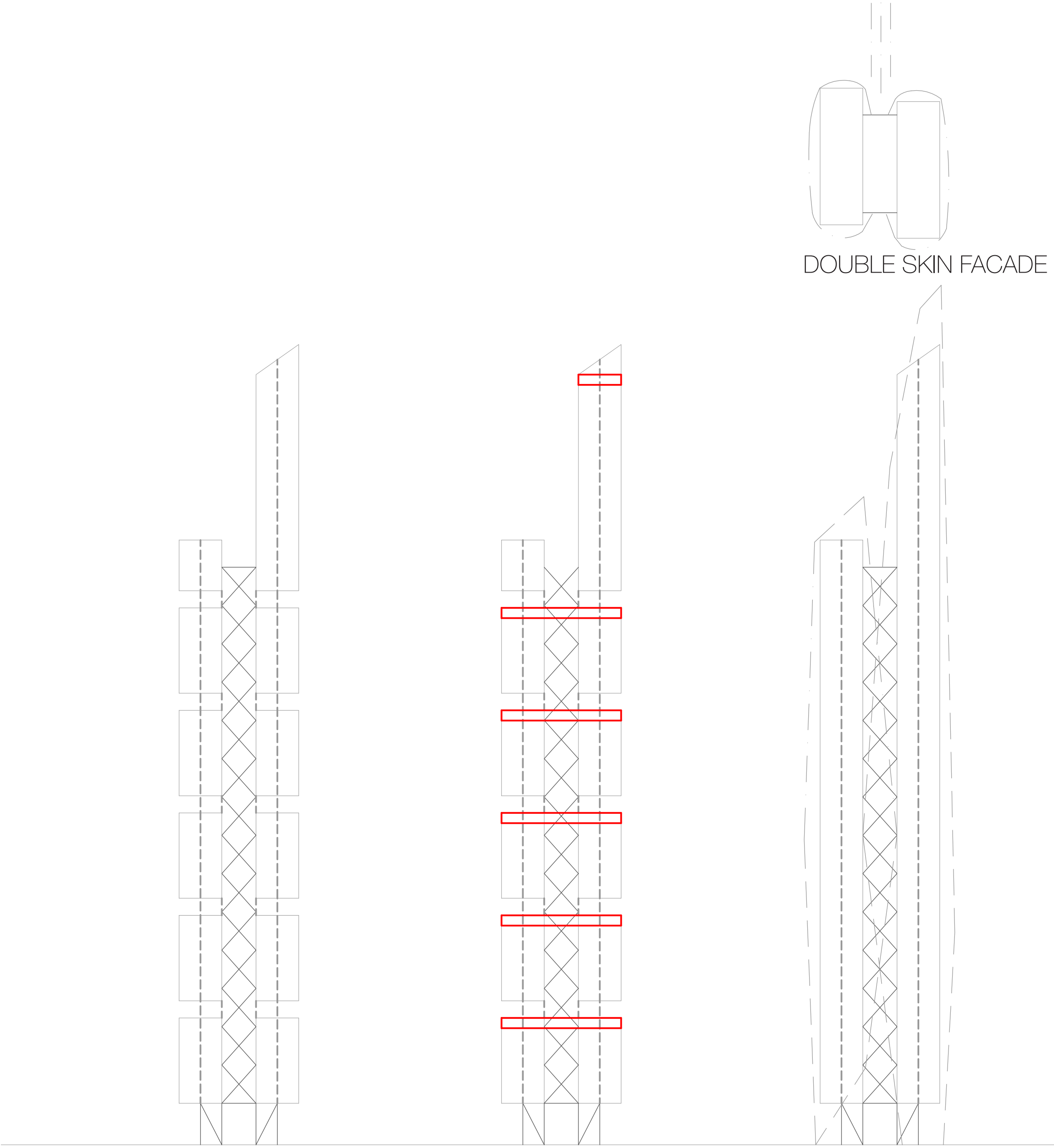
_concept



TYPICAL HONG KONG PODIUM TYPOLOGY

DIVIDED INTO TWO

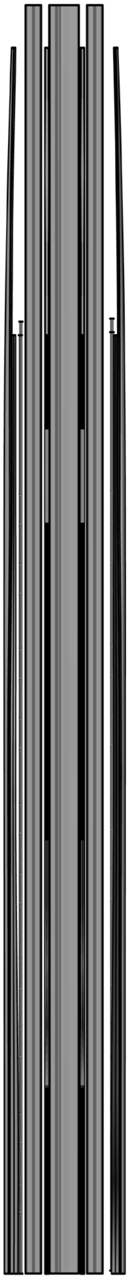
SPACE IN BETWEEN OPEN FOR PUBLIC AREAS AND ATRIUM



TOWER PODIUM ELEVATED THE BASE STAYS OPEN

DIVIDING IN STRUCTURAL ZONES

MAKING SPACE IN BETWEEN FOR NATURAL VENTILATION AND EASY WIND FLOW



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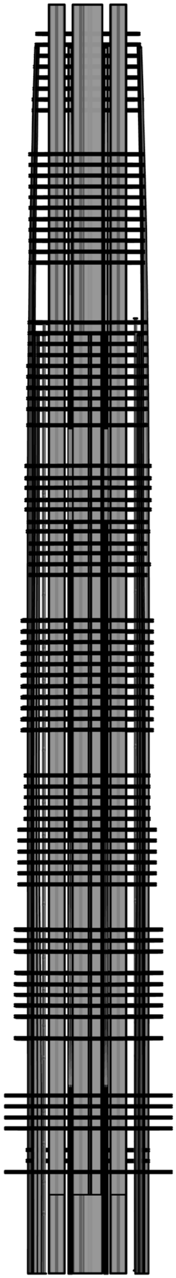

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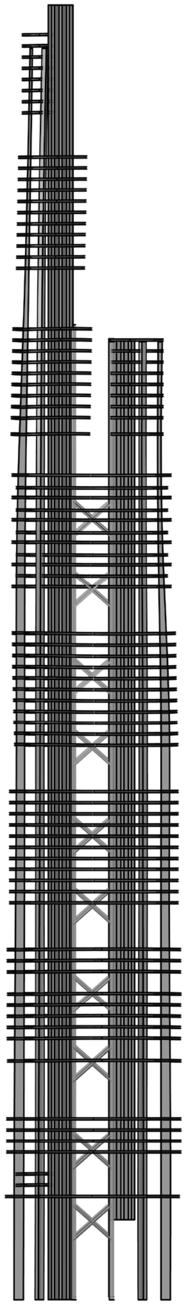

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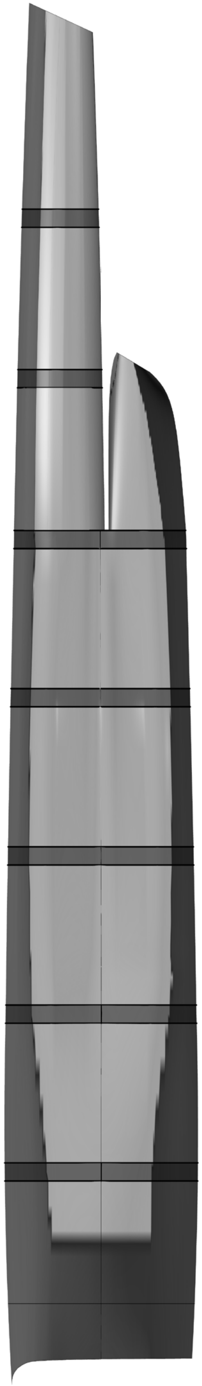


_structure

1.**CORE PROFILE**
(SUPER-COLUMN SYSTEM+CORE)

2.**ZONES** (LEVELS + COMPOSITE FLOORS)

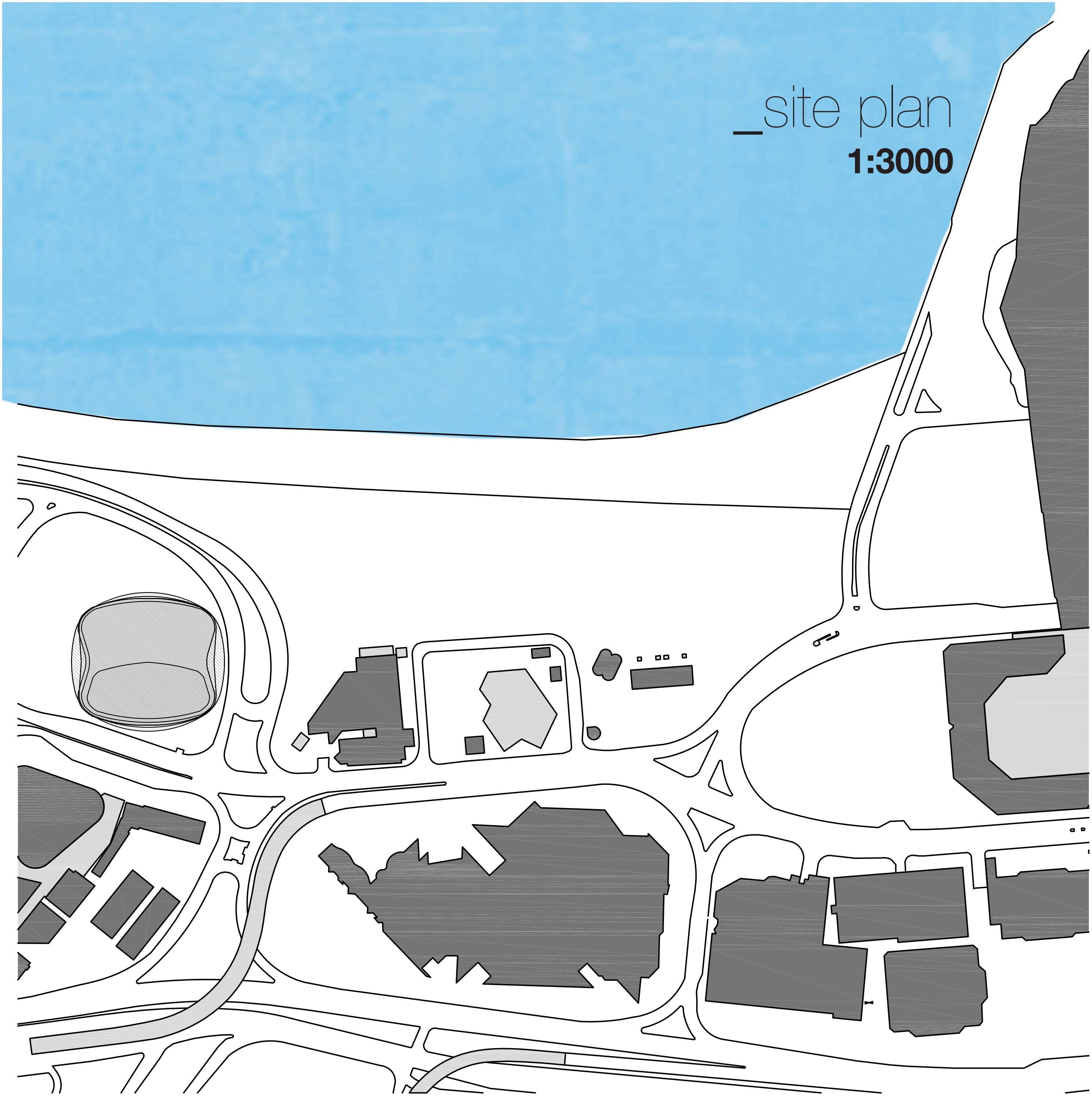
3.**SKIN+DOUBLE-BELT TRUSS**
(MECHANICAL LEVEL - WEST ELEVATION)

4.**SKIN+MECHANICAL LEVELS**
((MECHANICAL LEVEL - NORTH ELEVATION)

5.**EXTERIOR CURTAIN WALL+STRUCTURE**
(OPEN FACADE AT THE BASE)

4.

5.


_site plan
1:3000

_tower cross section

1:3000

+530,50 m

SITE

LOCATION: The New Central Harbour - Tamar Site, Central District, Hong Kong, China
AREA: 9,670 m^2

TOWER I

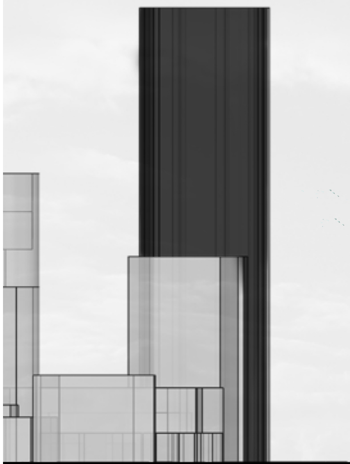
HEIGHT: 530,50 m
STORIES: 121 occupied floors
PROGRAM: Office, luxury hotel, residential, entertainment, retail, cultural venues, public areas, recreational venues, sky gardens observation deck

TOWER II

HEIGHT: 398,00 m
STORIES: 94 occupied floors
PROGRAM: Office, luxury hotel, entertainment, retail, residential, cultural venues, public space, recreational venues observation deck
AREA I + II: 430,510 m^2 above ground

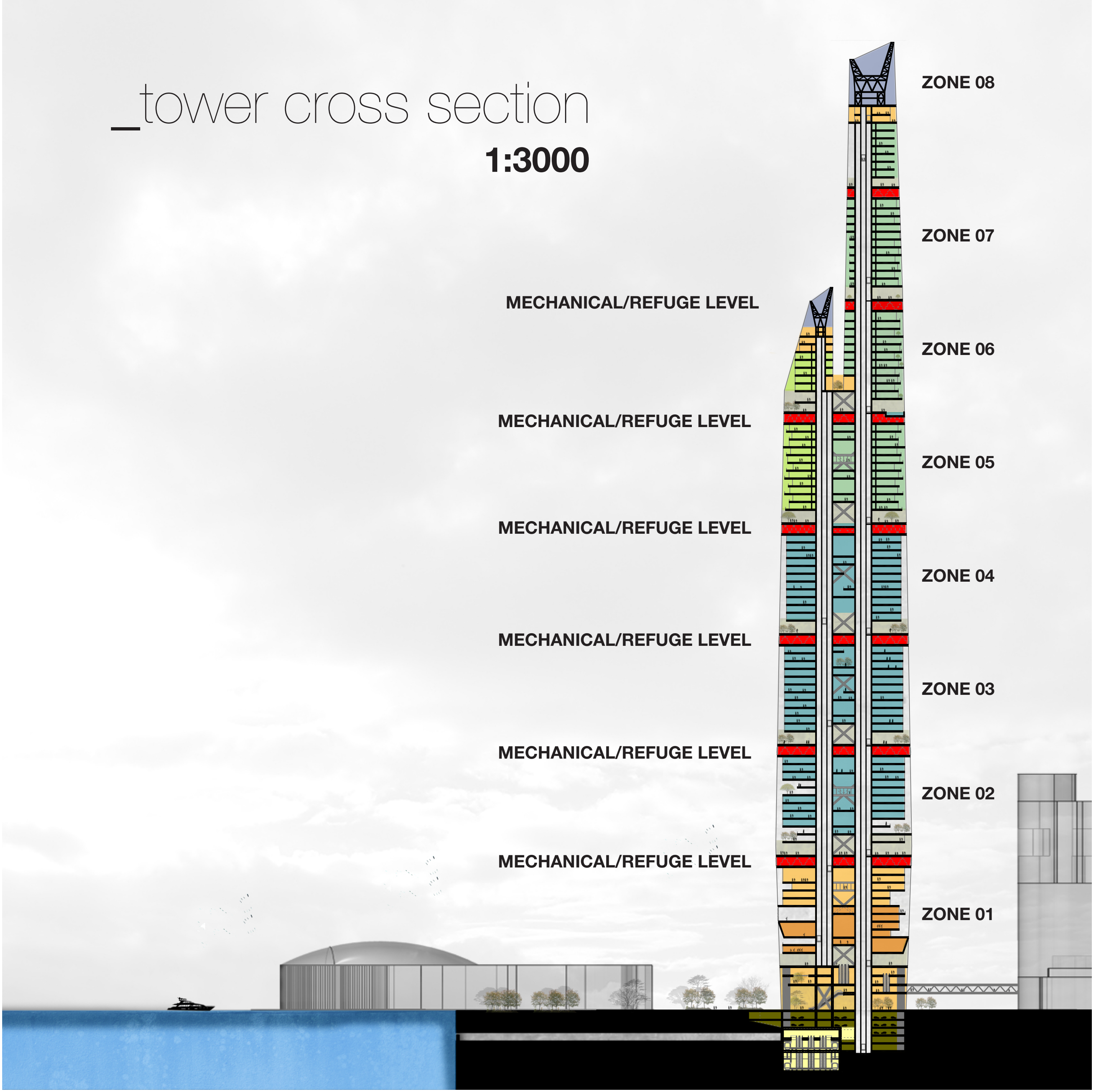
BASE

HEIGHT: 24.50 m
STORIES: 4 stories above ground
AREA: app. 25,000 m^2
PROGRAM: Luxury retail, bank, restaurant, coffee bar, multi-level garden. Below grade levels will be house retail, direct connection to the underground station, parking spaces service, and MEP functions.



_tower cross section

1:3000



ZONE 01
luxury retail, bank, restaurant, coffee bar, multi-level garden
direct connection to the underground station and parking spaces
sky lobby
educational (music school), cultural venues (galleries and performance space)
restaurant, coffee bar, entertainment
multi-level gardens

ZONE 02
sky lobby, restaurant, lounge bar, coffee bar
office levels, garden

ZONE 03
sky lobby, restaurant, lounge bar, coffee bar
office levels, gardens

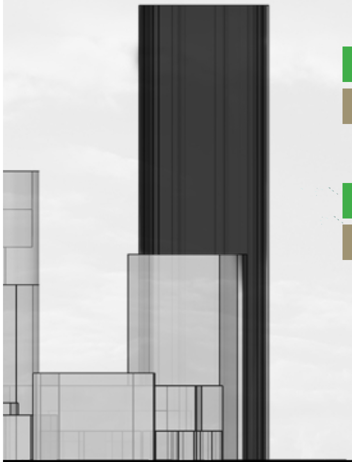
ZONE 04
sky lobby, restaurant, lounge bar, coffee bar
office levels, gardens

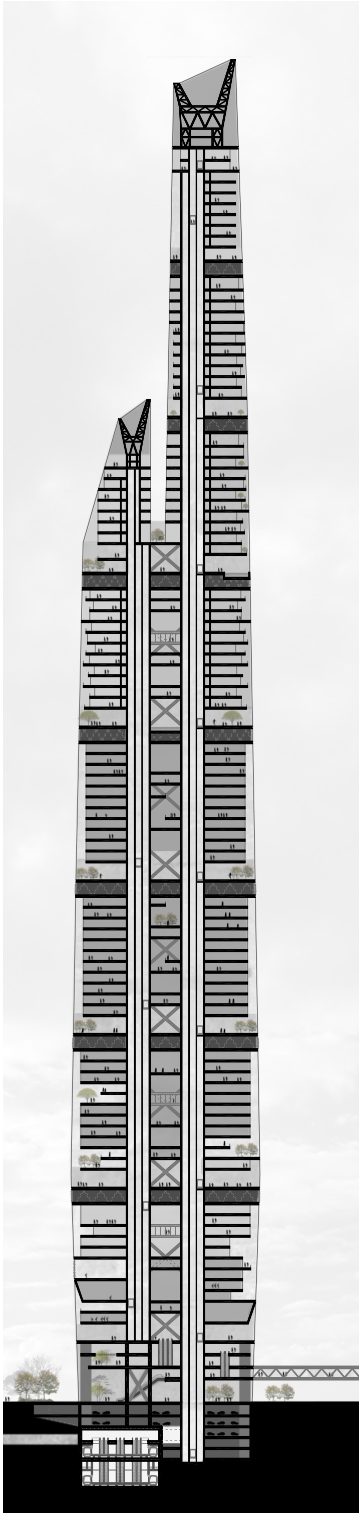
ZONE 05
luxury hotel, recreational, entertainment, residential,
gardens, sky terrace

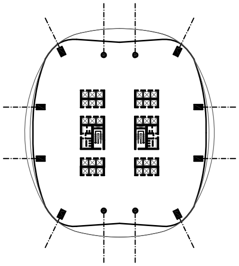
ZONE 06
luxury hotel, recreational, entertainment, residential, multi-level gardens,
observation deck, sky lobby, sky terrace

ZONE 07
luxury hotel, recreational, entertainment, residential, multi-level gardens,
observation deck, sky lobby, sky terrace

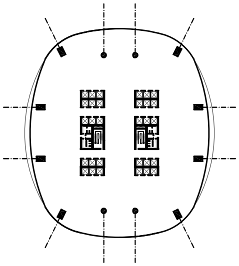
Distance between each Mechanical /Refuge Level is 61 m.







ZONE 04



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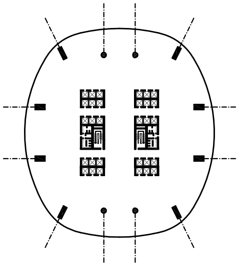
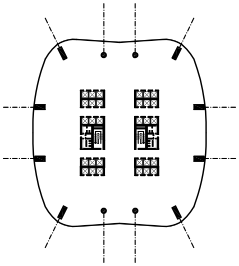
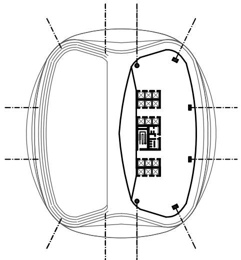


ZONE 02



ZONE 01



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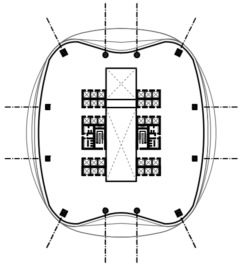

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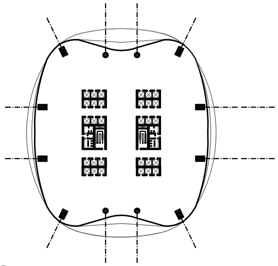
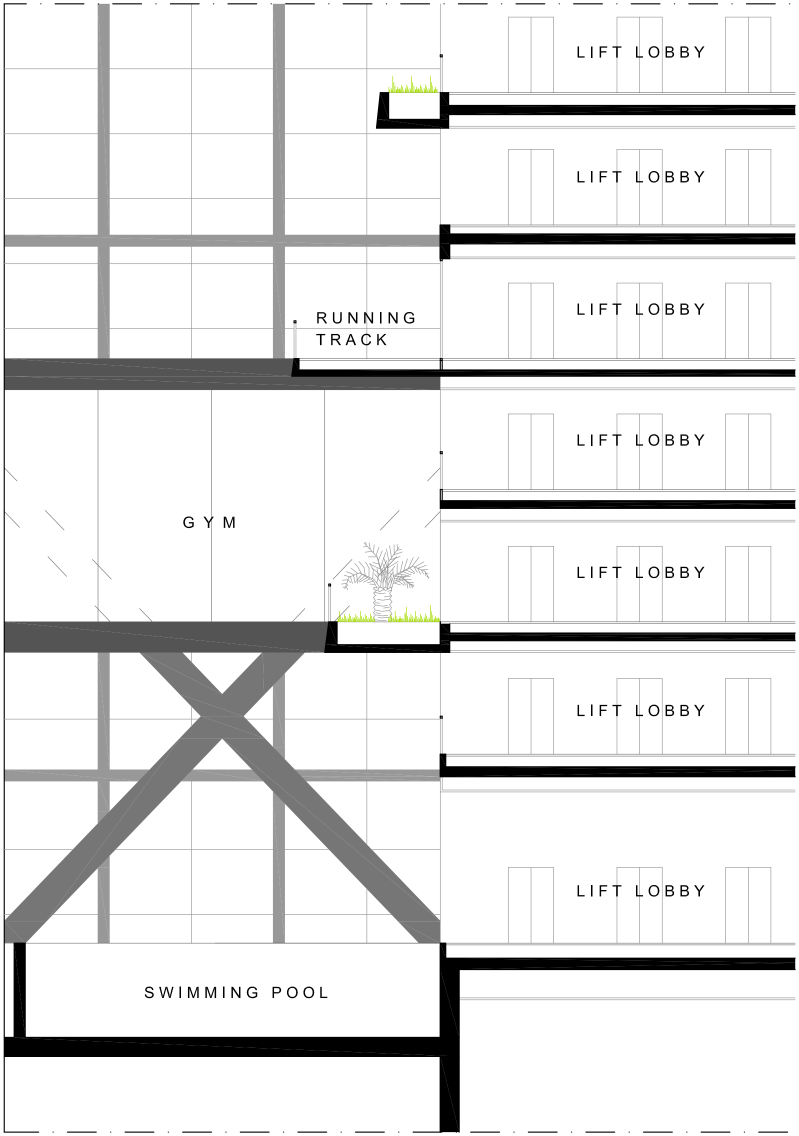


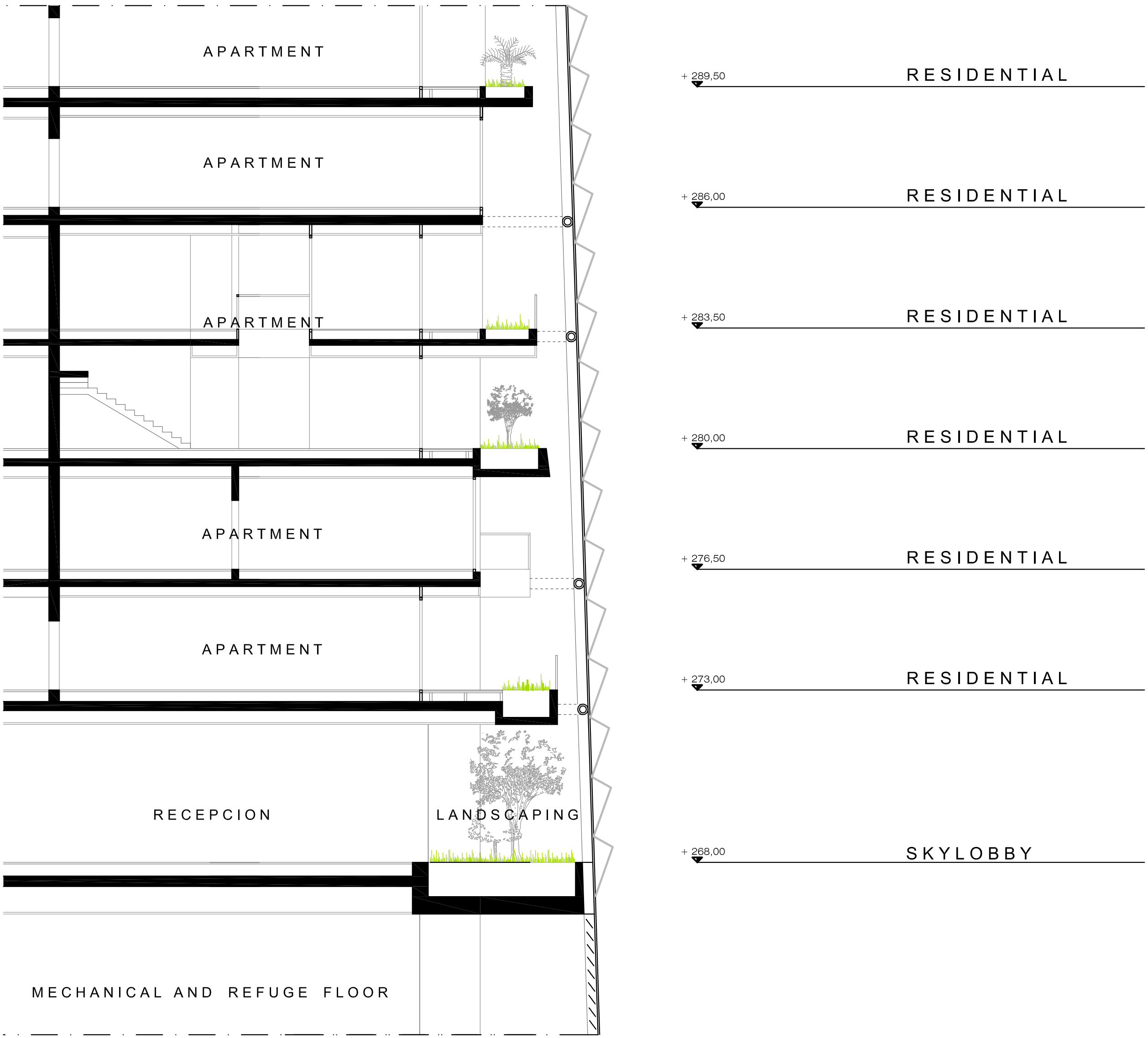
ZONE 05

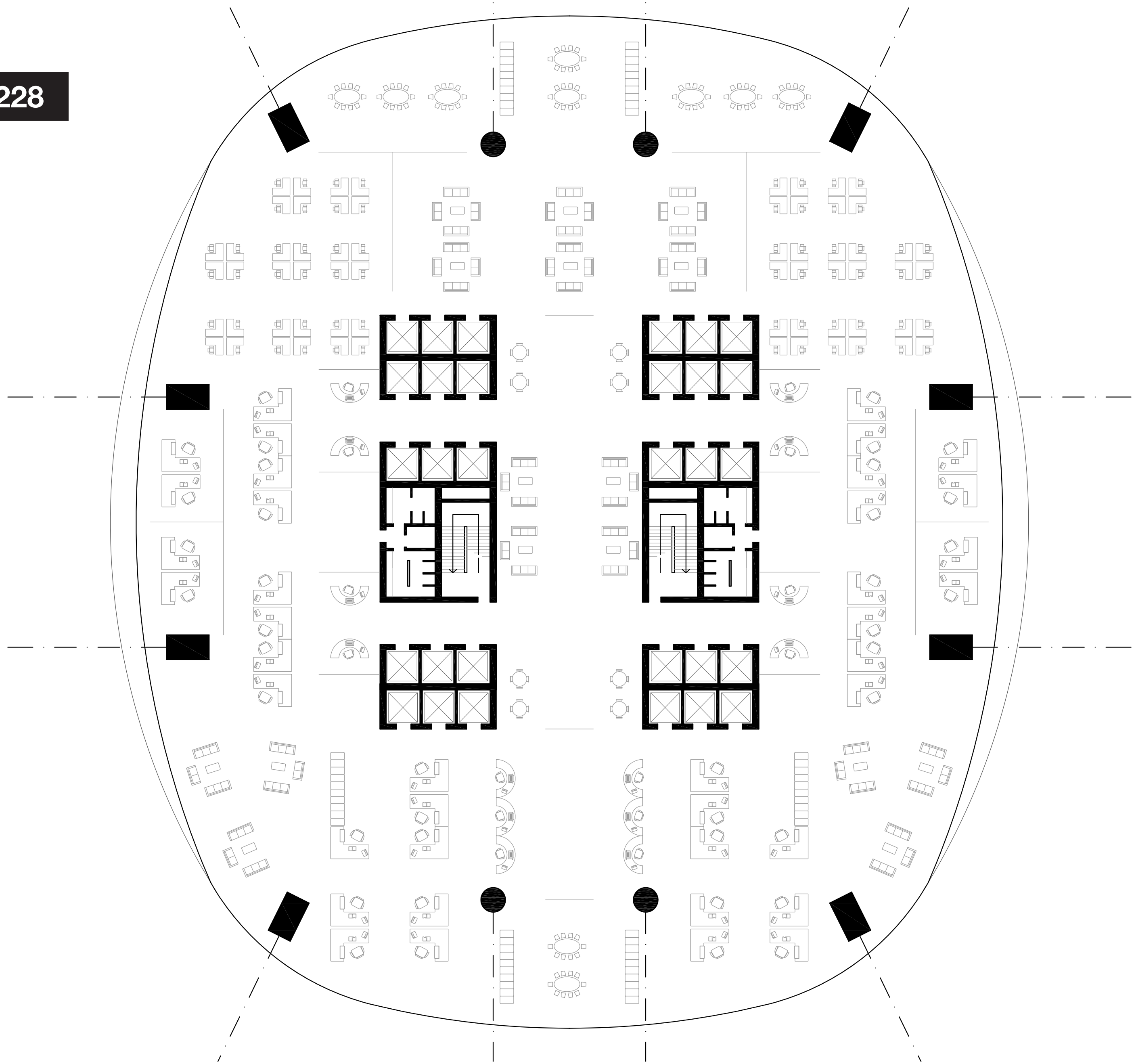
_**BASE** cross section

1:750

_cross section
1:200

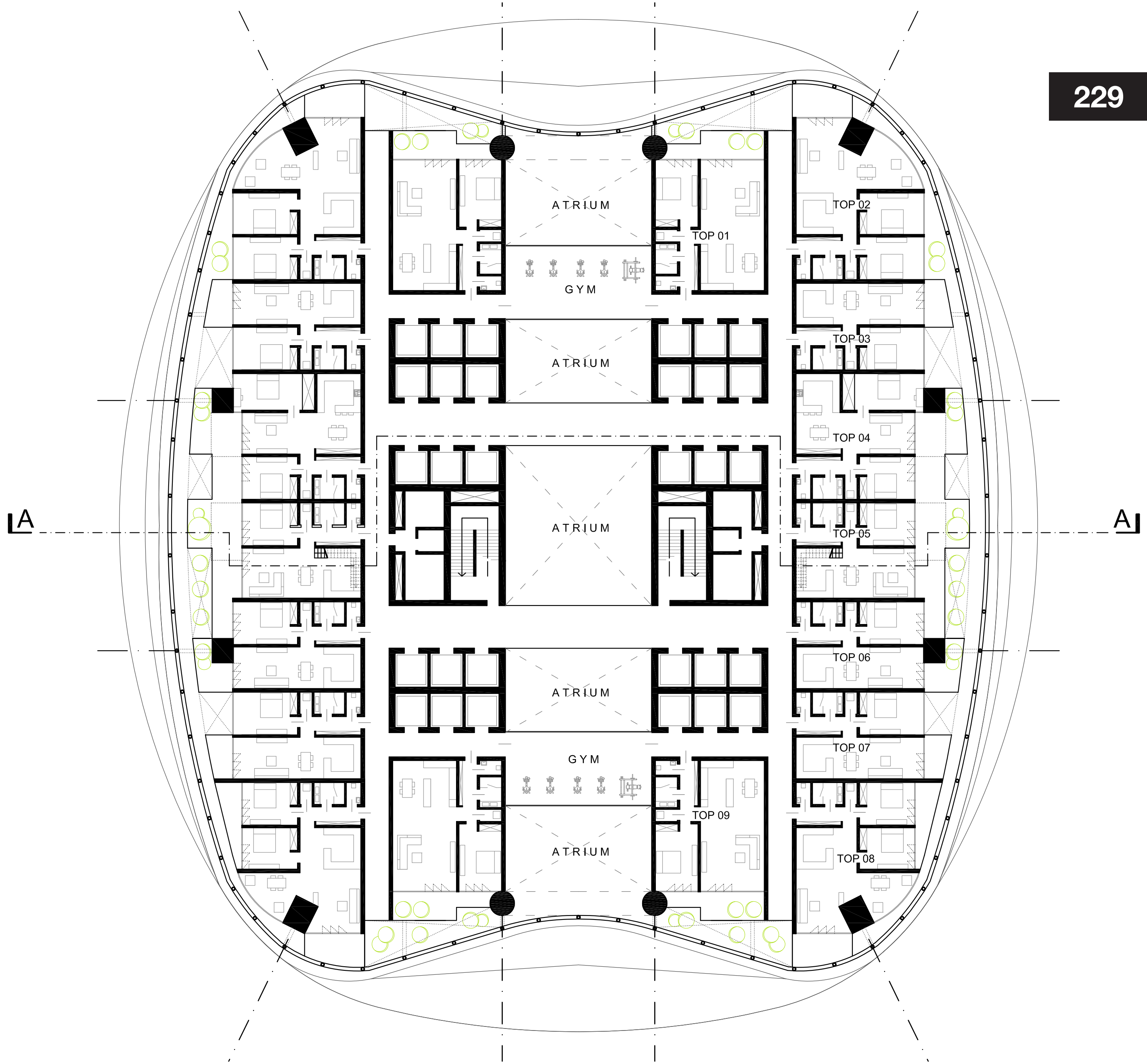



APARTMENT
APARTMENT
APARTMENT
APARTMENT
APARTMENT
RECEPCION
LANDSCAPING
MECHANICAL AND REFUGE FLOOR
+ 289,50
RESIDENTIAL
+ 286,00
RESIDENTIAL
+ 283,50
RESIDENTIAL
+ 280,00
RESIDENTIAL
+ 276,50
RESIDENTIAL
+ 273,00
RESIDENTIAL
+ 268,00
SKYLOBBY

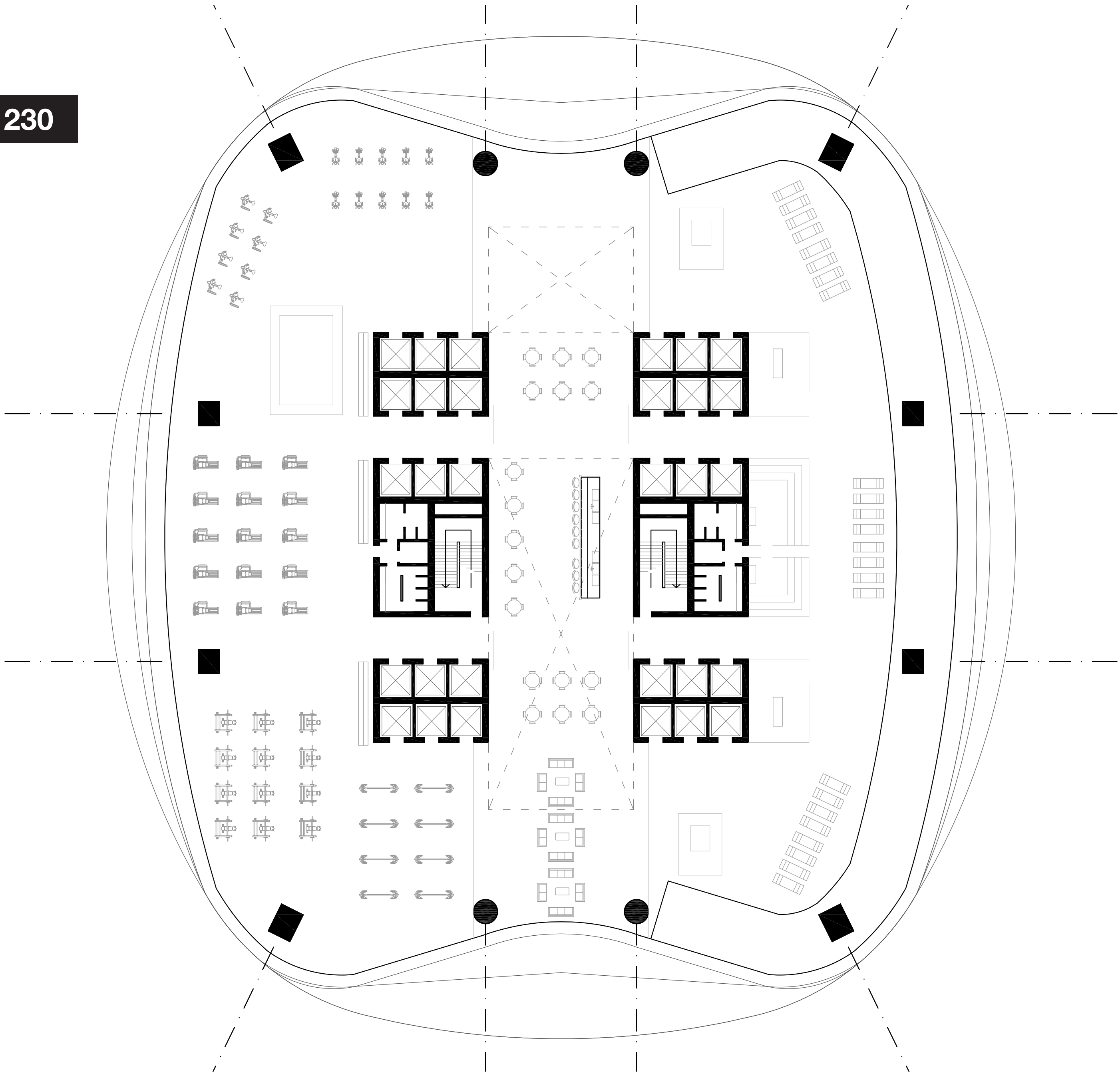


_floor plans

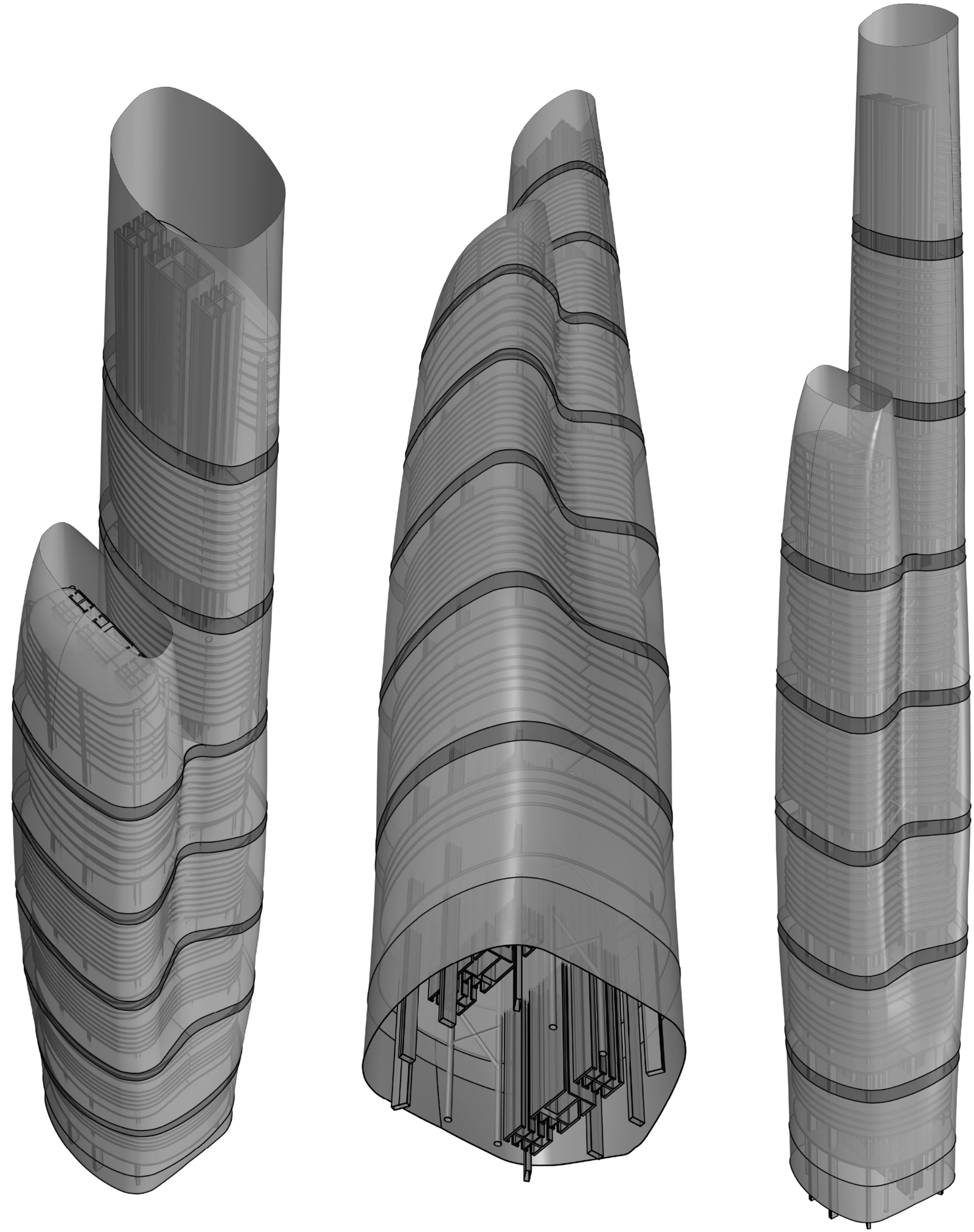
OFFICE LEVEL **1:200**



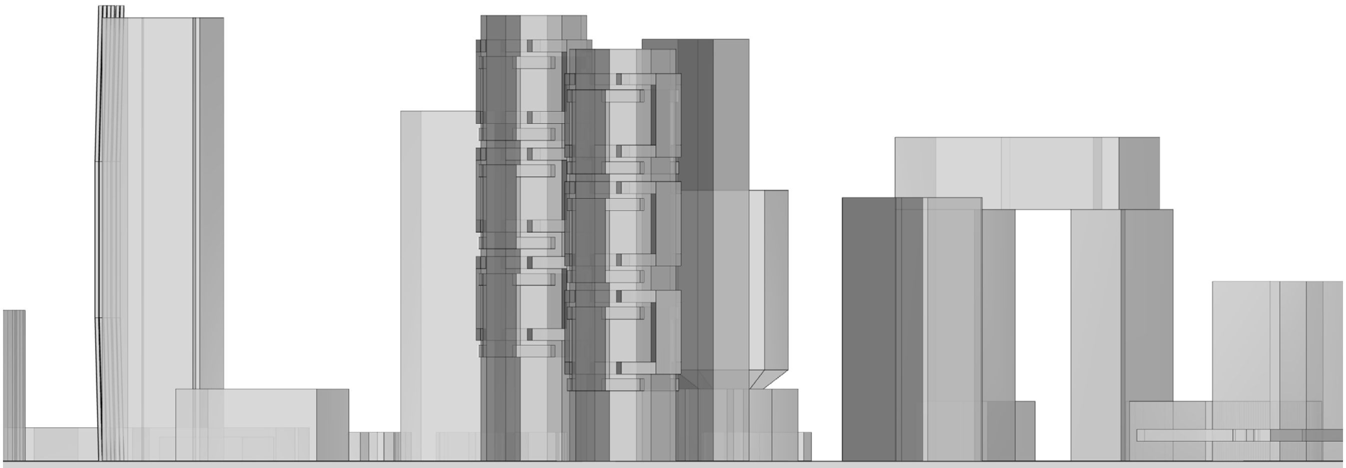
RESIDENTIAL LEVEL **1:200**



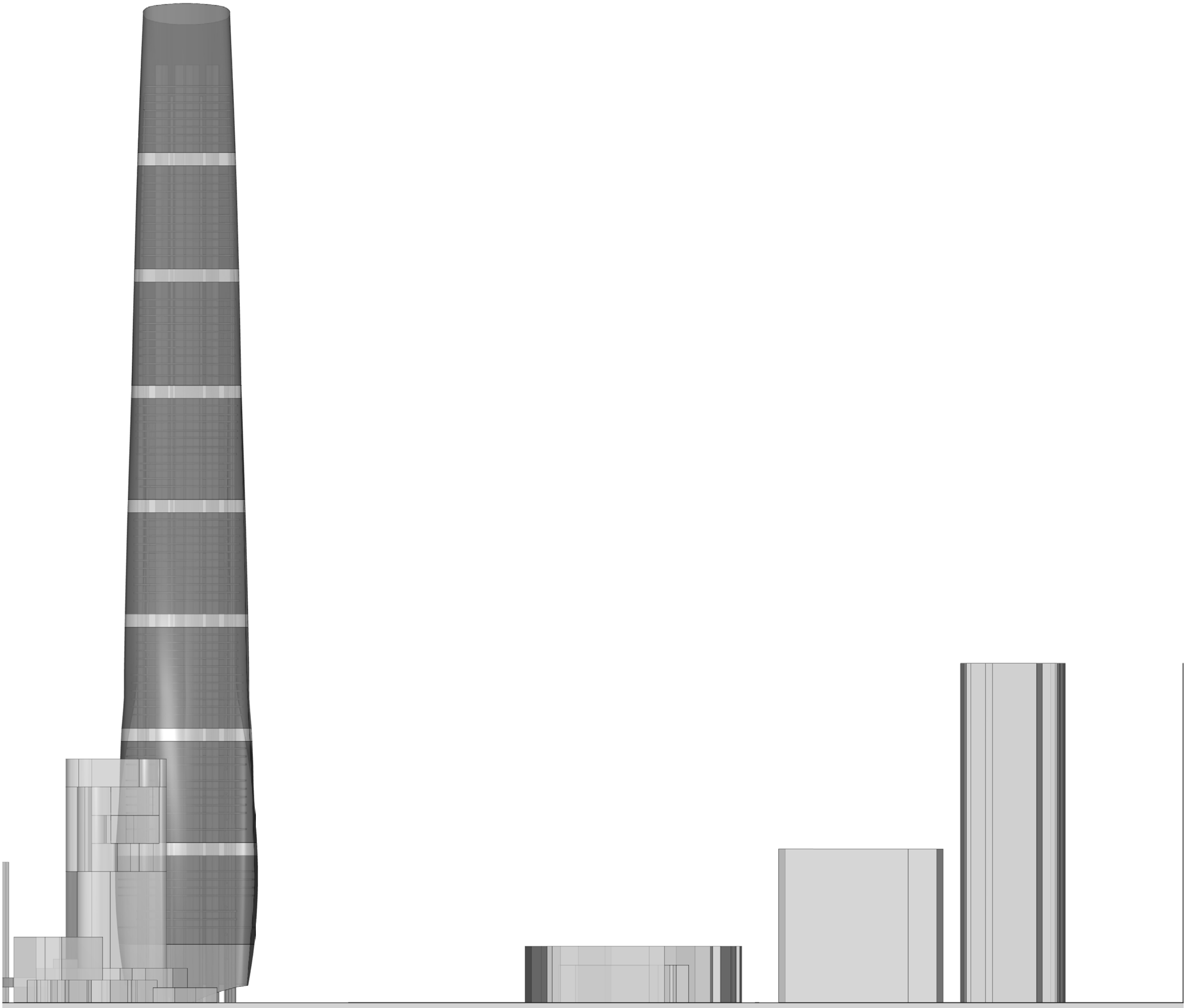
RECREATIONAL LEVEL **1:200**



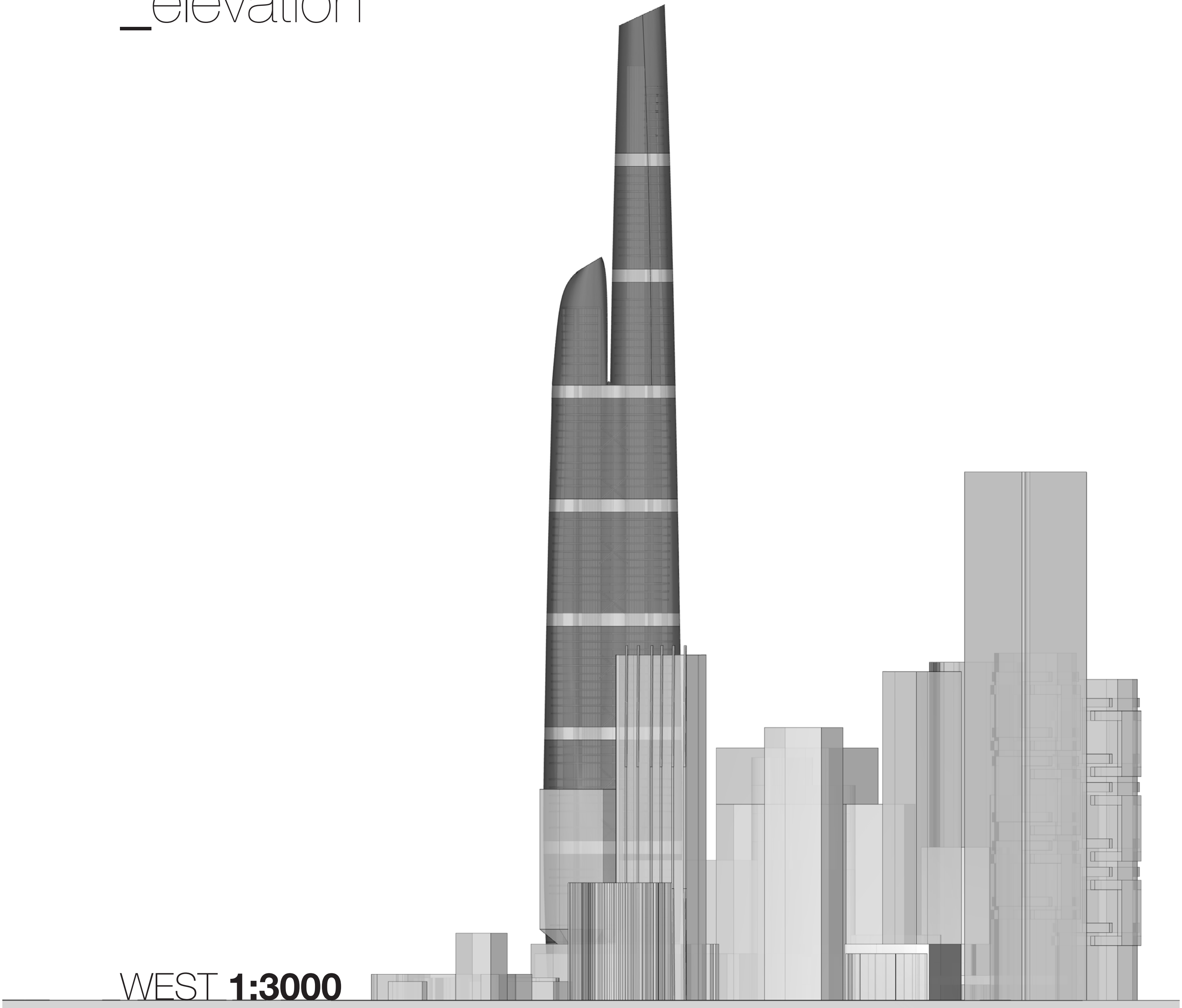
_elevation



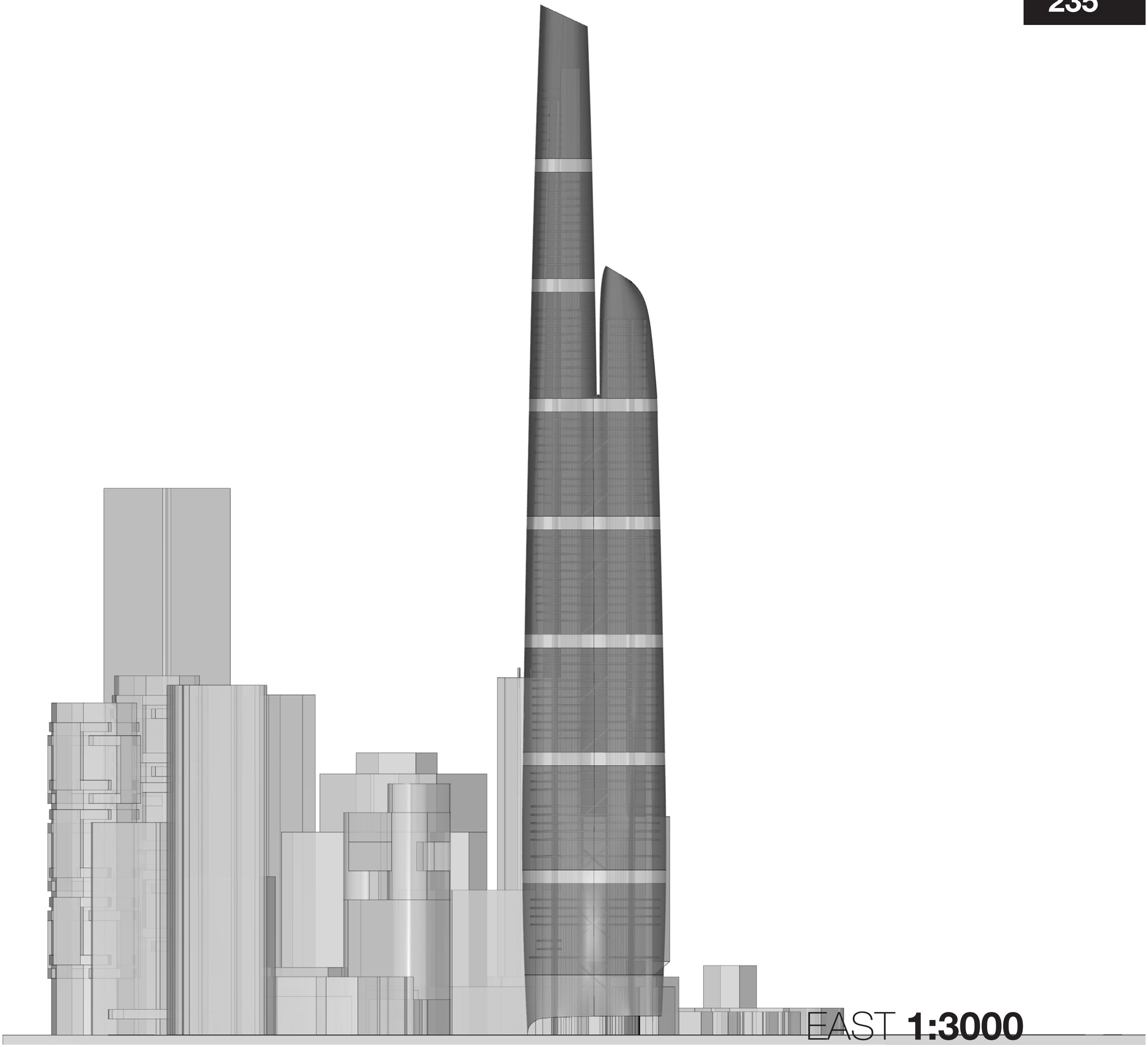
SOUTH **1:3000**



_elevation

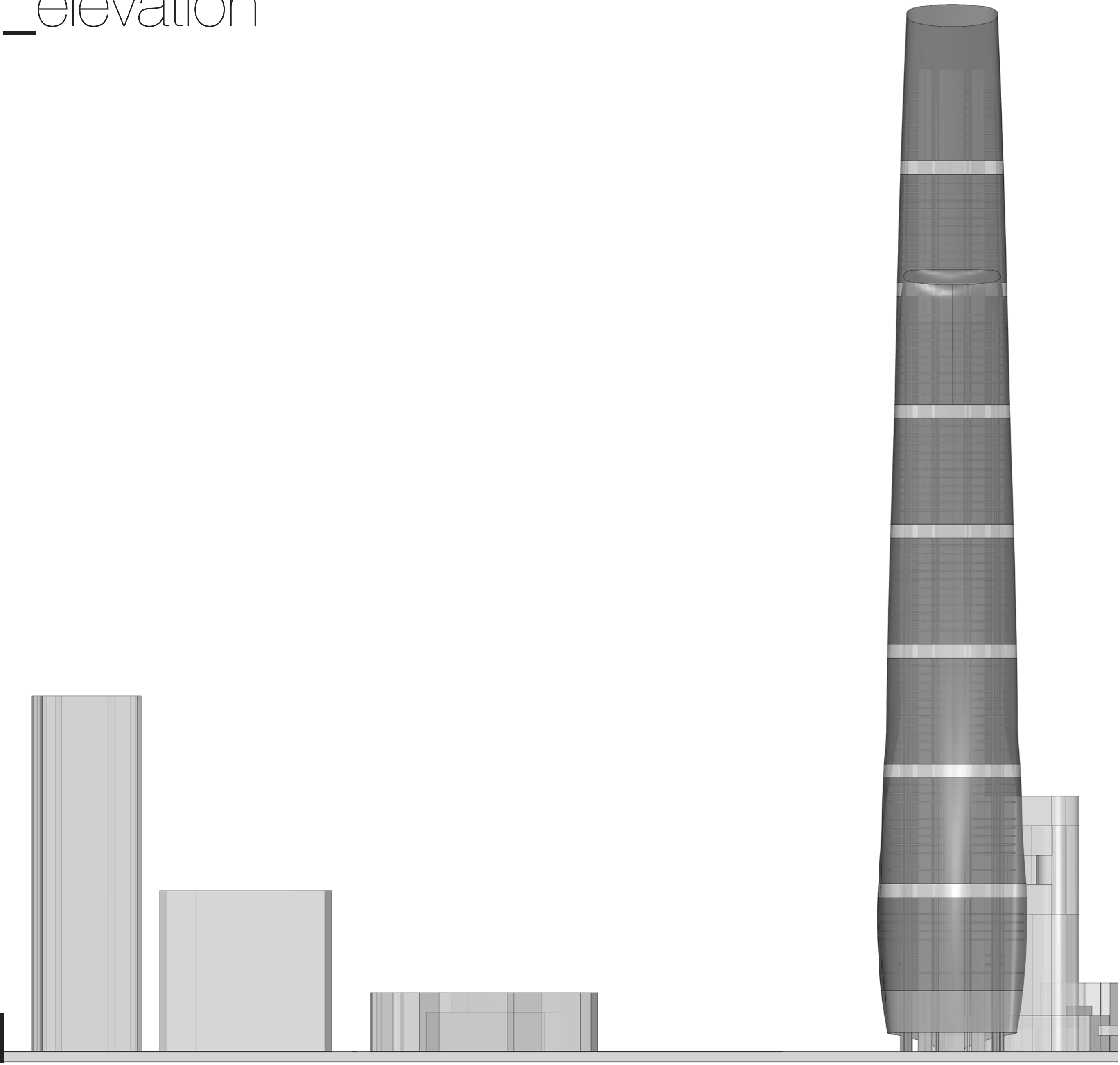


WEST **1:3000**

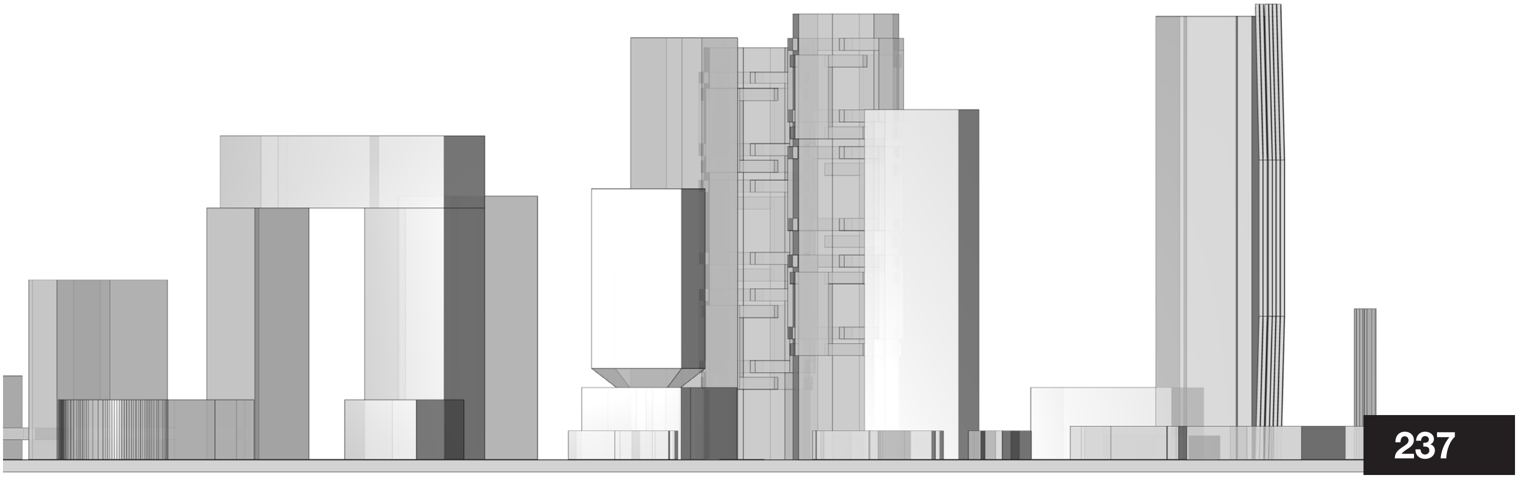


EAST **1:3000**

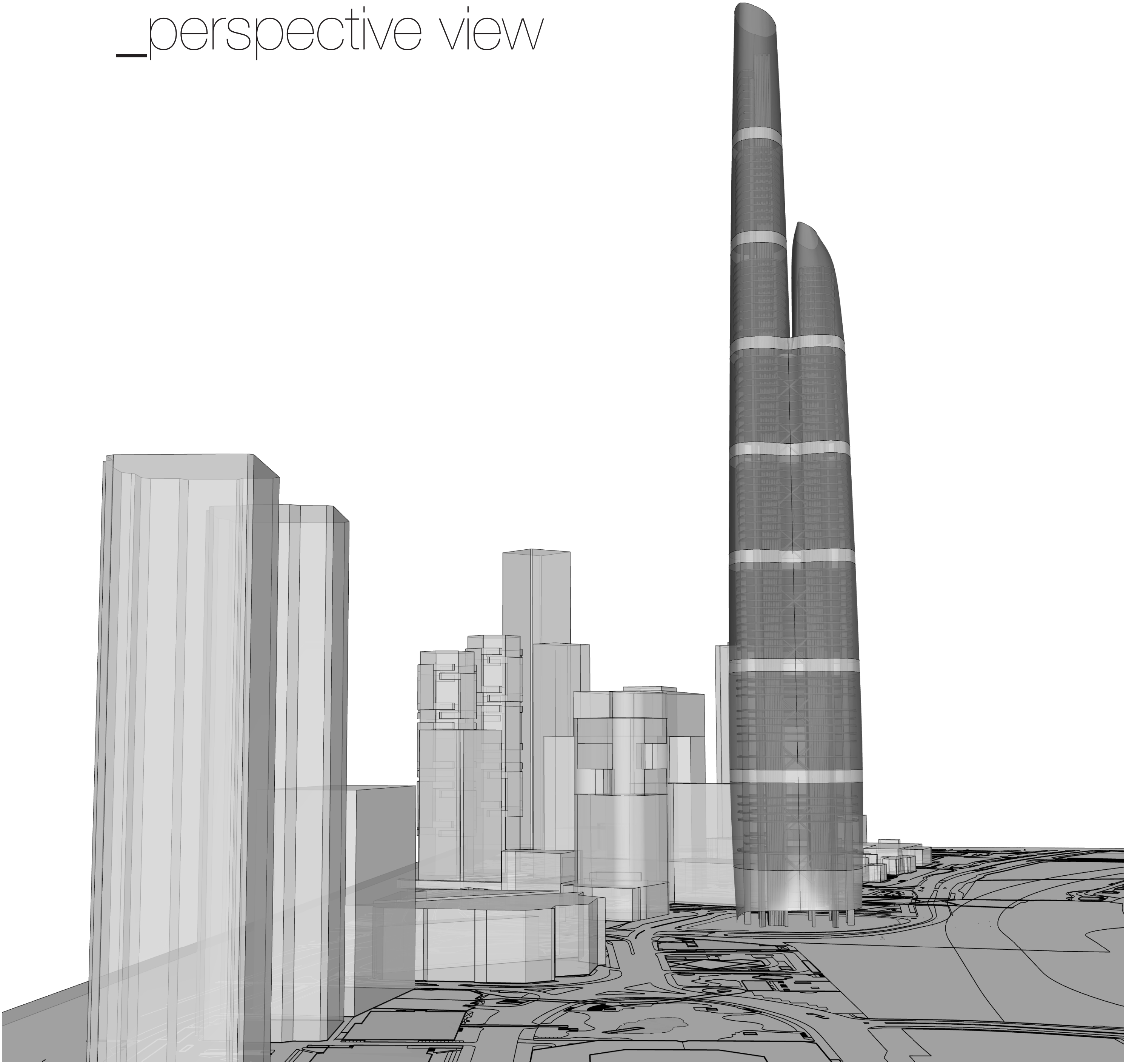
_elevation

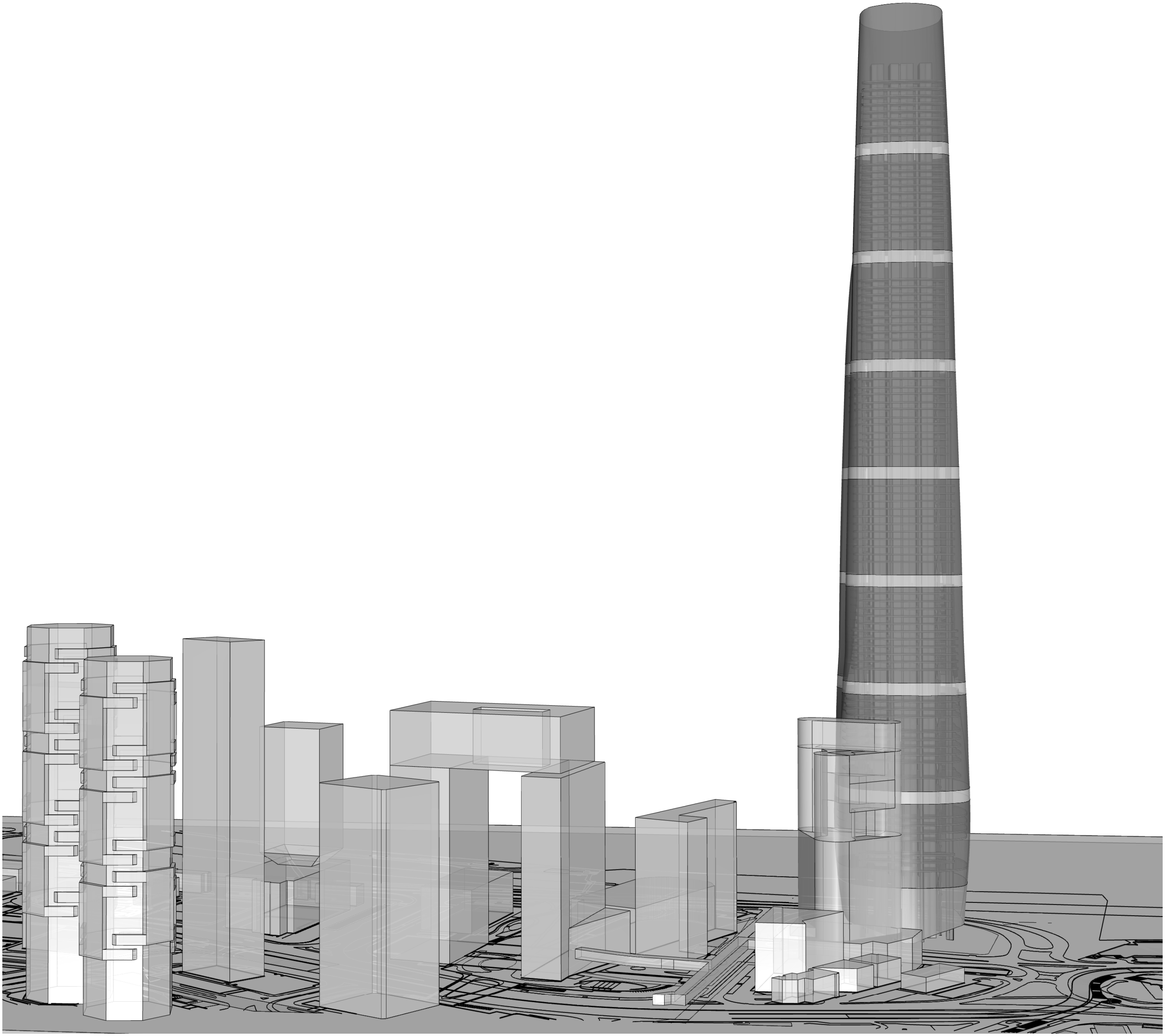


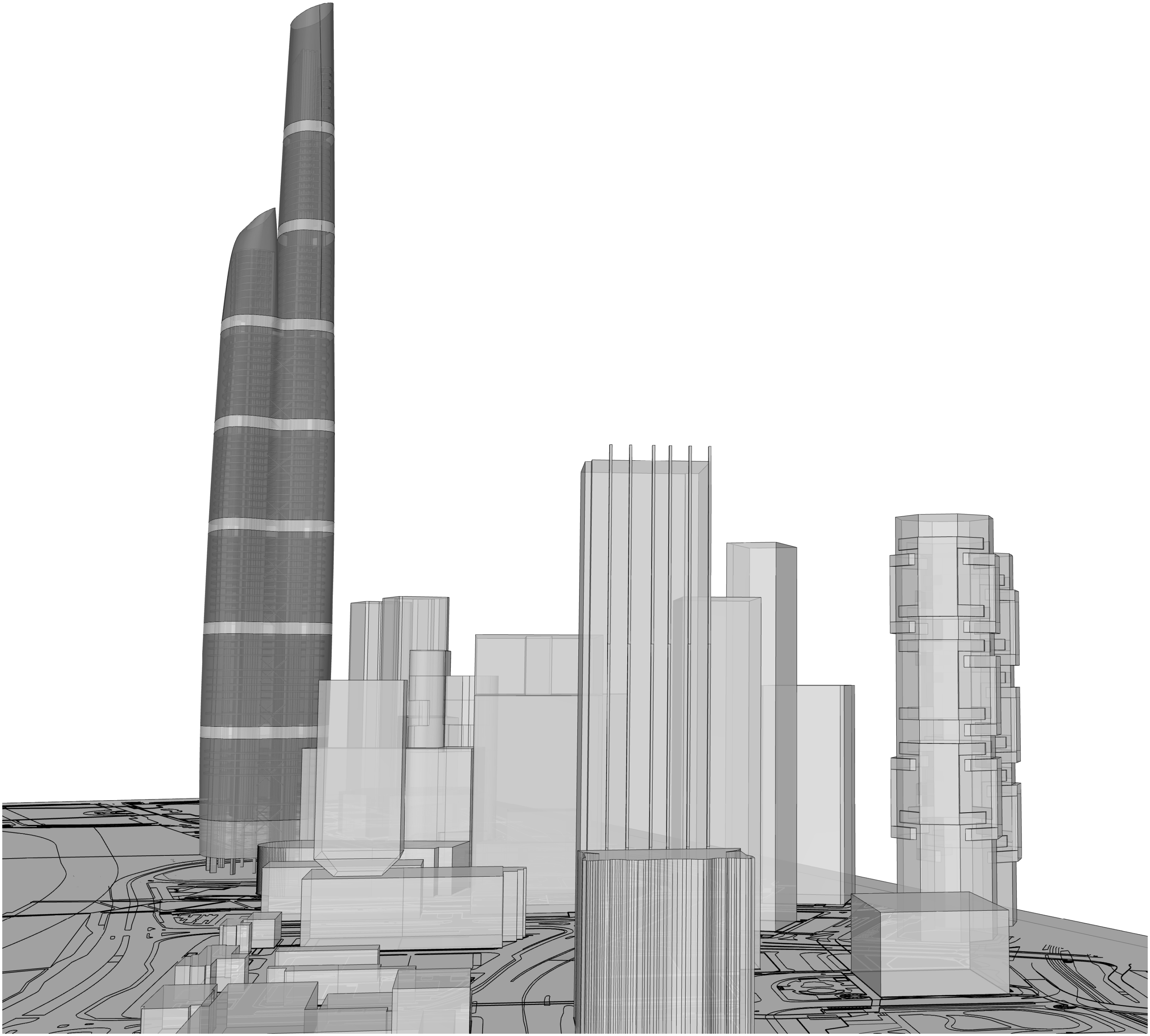
NORTH **1:3000**

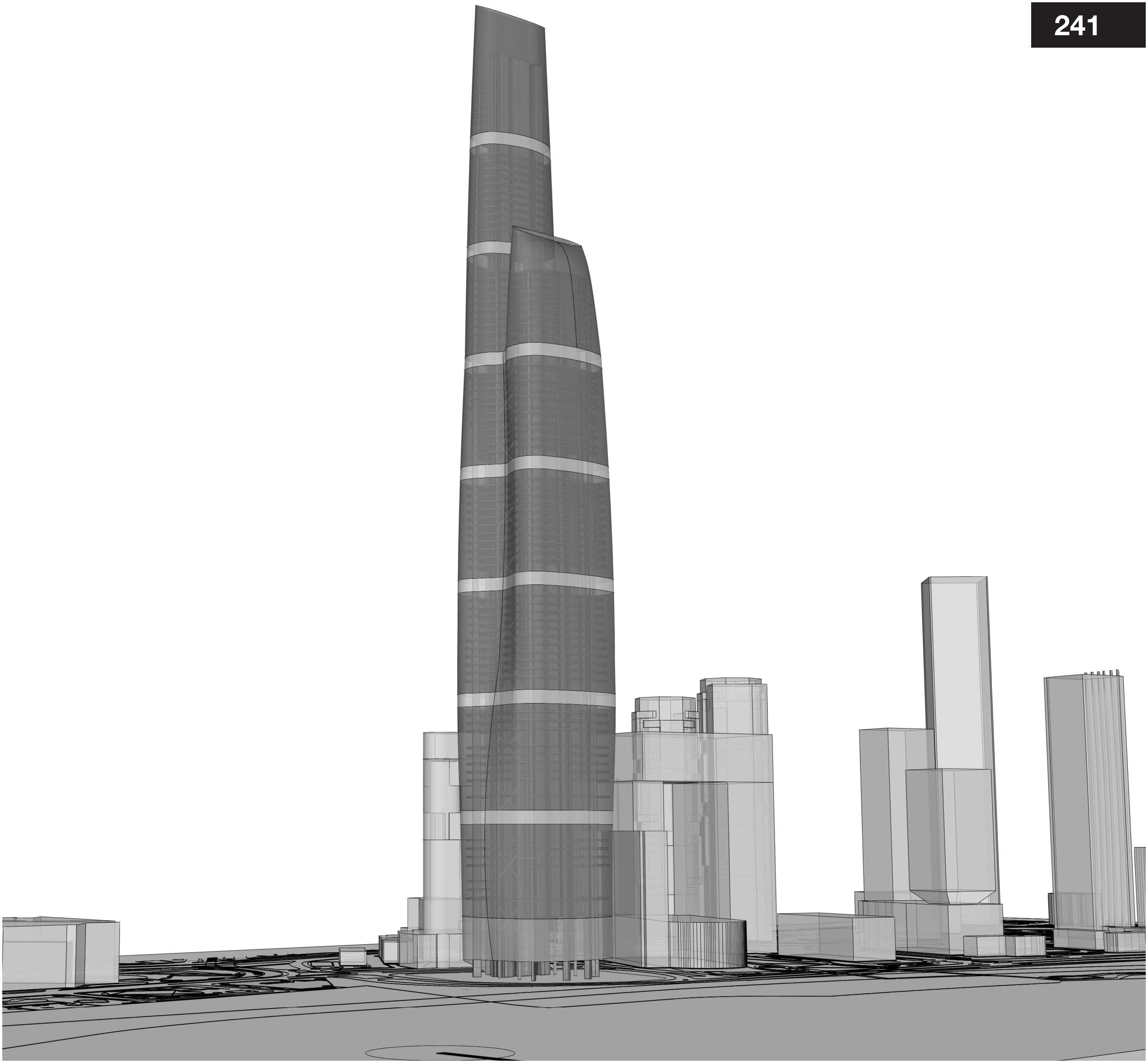


_perspective view









bibliography

LIST OF LITERATURE

1. Ng, Edward: Designing High-Density Cities. For Social and Environmental Sustainability, UK 2013
2. Al-Kodmany, K./Ali, M.M.: The Future of the City. Tall Buildings and Urban Design, UK 2013
3. MVRDV: KM3. Excursions on Capacities, Rotterdam 2005
4. Yeang, Ken : Bioclimatic Skyscrapers, London 1994
5. Yeang, Ken : Reinventing the Skyscraper, UK 2002
6. Hart, Sara: Eco Architecture, UK 2011
7. Jencks, Charles : Skyscrapers - Skycities, London 1980
8. Campi, Mario : Skyscrapers, Basel 2000
9. Shelton, Barrie/Karakiewicz, Justyna/Kvan, Thomas: The Making of Hong Kong. From Vertical to Volumetric, London-New York 2011
10. Christ, Emanuel/Gantenbein, Christoph: Hong Kong Typology. An Architectural Research on Hong Kong Building Types, Zürich 2012
11. Moudry, Roberta:The American Skyscraper: Cultural Histories, New York 2005
12. Mallgrave, Harry Francis : Modern Architectural Theory, A Historical Survey, 1673-1968, New York 2005
13. Frempton, Adam/D.Solomon, Jonathan/ Wong, Clara: Cities Without Ground.A Hong Kong Guidebook, Barkeley 2012
14. Firley, Eric/ Gimbal, Julie : The Urban Towers Handbook, UK 2011
15. Foster, Norman : 1978 – 1985, o.O.1989
16. Foster, Norman : Foster Catalogue, Munich 2001
17. Lepik, Andreas : Skyscrapers, Munich 2004
18. Koolhaas, Rem: Delirious New York, New York 1994
19. Jodidio, Philip : AE Architecture in the Emirates, Cologne 2007
20. Wood, Antony(CTBUH): Best Tall Buildings 2011, New York 2012
21. Welterova, Barbora : Tall With Benefits, Hong Kong 2012
22. Klotz, Heinrich : New York Architecture 1970-1990, o.O. 1982
23. Lambert, Phyllis: Mies in America, New York 2001
24. Yeung, Yue Man : Fifty Years of Public Housing in Hong Kong: A Golden Jubilee Review and Appraisal, Hong Kong, 2003

INTERNET SOURCES:

Krummeck, Stefan : A New Urbanity. The Relationship between Towers and Urbanism, in: Civil Engineering 163, November 2010, 4-11
Oniline under: http://www.ctbuh.org/LinkClick.aspx?fileticket=FXmFxM7uOag-%3D&tabid=302&language=en-US (20.01.2014)

Ali,M/Armstrong,P: Sustainability and the Tall Building: Recent Developments and Future Trends, in: AIA Illinois Central Symposium Conference proceeding (2010)
Online under: http://www.ctbuh.org/Publications/TechnicalPapers/tabid/71/Default.aspx (03.05.2013)

Wimer,R/Baker,W/Nagis,M/Mazeika,A : Case Study: Greenland's Suzhou Center, Wujiang, in: CTBUH Journal Issue III 03-19., 2012
Online under: http://technicalpapers.ctbuh.org (07.01.2014)

Xia,J/Poon,D/Mass,D.C : Case Study: Shanghai Tower, in: CTBUH Journal Issue 2, 2010
Online under: http://technicalpapers.ctbuh.org (23.12.2013)

CTBUH (Sep.1,2010): Tallest World Records, CTBUH Journal 2010 Issue IV, 44-45
Online under: http://ctbuh.org/LinkClick.aspx?fileticket=3T9bK-9cWTHE%3d&tabid=1108&language=en-US (4.12.2013)

Hargrave, Josef/ Wilson, Ralph: Imagining the Tall Building of the Future, CTBUH Journal 2013 Issue III, 20-25.
Online under: http://www.ctbuh.org/LinkClick.aspx?fileticket=SxmFiYCs-B00%3D&tabid=53&language=en-US (07.01.2014)

CTBUH, (Sep. 1, 2010) : Tallest World Records, CTBUH Journal 2010 Issue IV, 44-45.,Online under:
http://ctbuh.org/LinkClick.aspx?fileticket=3T9bK9cWTHE%3d&tabid=1108&language=en-US (4.12.2013)

CTBUH, (Dec. 8, 2011) : The Tallest 20 in 2020: Entering the Era of the Megatall,1-7., Online under:
http://ctbuh.org/TallBuildings/HeightStatistics/BuildingsinNumbers/TheTallest20in2020/tabid/2926/language/en-US/Default.aspx (15.10.2013)

Nathaniel Hollister/ Jan Klerks/ Antony Wood , (Sep. 1, 2010) : New York City Scrapers, CTBUH Journal 2011 Issue lll, 54-55., Online under:
http://ctbuh.org/LinkClick.aspx?fileticket=eb2Me8uNw3A%3d&tabid=1108&language=en-GB (13.12.2013)

Diana Zheng (8.8.2012) : A review of Cradle to Cradle: Remaking the Way We Make Things, Cool Climate Blog (dianaz's Blog), Online under:
http://coolclimate.berkeley.edu/node/427 (9.7.2013)

Hargrave, Josef/ Wilson, Ralph: Imagining the Tall Building of the Future, CTBUH Journal 2013 Issue lll, 20-25
Online under: http://www.ctbuh.org/LinkClick.aspx?fileticket=SxmFiYCsB00%3D&tabid=53&language=en-US (07.01.2014)

Abel, C.: The Vertical Garden City: Towards a New Urban Topology, CTBUH Journal 2010 Issue 2, 20-25
Online under: http://cicarchitecture.org/members/pics/2010IssueII_AbelC.pdf (07.01.2014)

MAGAZINE SOURCES:

Tieben, Hendrik: Hong Kong's Urban Transformation 2005-2012: Areview and Outlook, in: FuturArc Volume 29, Mar-Apr 2013, 46.-55.

AUDIOVISUAL SOURCES:

Feinberg, David: "The Devastating Effects of Pollution in China", 2012; Vice Dec 13, 2012

Haines-Stiles, Geoff: Earth: The Operators' Manual, (Segment 2: Humans & Energy) USA 2011; PBS (Public Broadcasting Service) Apr 11, 2011

McKenzie, David : "China's toxic smog problem",Beijing 2013; CNN Oct 23, 2013

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http://organicisminarchitecture.files.wordpress.com/2013/11/arcology-4.jpg (15.03.2014)
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http://organicisminarchitecture.files.wordpress.com/2013/11/soleri_babel.jpg (17.03.2014)
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http://wwwdelivery.superstock.com/WI/223/1848/PreviewComp/SuperStock_1848-200969.jpg (22.03.2014)
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http://enzymefh.com/projetz/wp-content/uploads/2013/04/Stacked_Hamburger_Cutaway_hires1-500x629.jpg (15.12.2013)
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http://i106.photobucket.com/albums/m257/beyondblog/kenyeang.jpg (22.03.2014)

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http://upload.wikimedia.org/wikipedia/commons/7/7a/Biological_and_technical_nutrients_%28C2C%29.jpg (28.12.2013)
http://moss-design.com/wp-content/uploads/2012/10/19_how_c2c.png (26.01.2014)
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http://cdn0.lostateminor.com/wp-content/uploads/2013/02/Post3_Skyscraper2050_1.jpg (07.02.2014)
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http://m.dac.dk/Images/img/1920x1200M/(41778)/41778/amager-bakke-09.jpg (10.05.2014)
http://www.hitmedbatterierne.dk/Amager_Bakke/~/media/Images/Hjemmesidefotos/AmagerBakkeUpdate/ABbilleder%202013/Amager%20Bakke%20winter%20activities.ashx (10.05.2014)
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http://www.constructionweekonline.com/pictures/SOM_3.jpg (16.03.2014)
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http://www.arthitectural.com/wp-content/uploads/2014/01/HANSAR-8-2010-PBH-007.jpg (15.04.2014)
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http://c1038.r38.cf3.rackcdn.com/group1/building3387/media/111TG047_medium.jpg (02.05.2014)
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http://www.e-architect.co.uk/images/jpgs/thailand/hansar_bangkok_w270811_4.jpg (14.05.2014)
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https://www.google.at/maps/place/Dong+N an+Lu/@22.3806621,113.836789,85587m/data=!3m1!1e3!4m2!3m1!1s0x35b5c9b7110480f3:0x-d6a3311623cf74f0 (15.04.2014)
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http://www.listofimages.com/wp-content/uploads/2013/01/hong-kong-china-skyscraper-clouds-city-sky-world.jpg (25.01.2014)
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http://www.hdwallpapers.in/walls/hong_kong_skyline-normal.jpg%20IFC (15.04.2014)
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http://www.mheu.org/portal/ressources/imageBank/3/979,L2-14-46.jpg (17.02.2014)
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http://31.media.tumblr.com/tumblr_m5o6z5Z5EO1rruc14o1_1280.jpg (17.02.2014)
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http://www.davidsheen.com/rumblepie/images/14a.jpg (14.12.2013)
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http://placemanagementandbranding.files.wordpress.com/2012/07/skywalks_largest.jpg (03.03.2014)
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http://www.nysun.com/pics/6877.jpg (14.02.2014)
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http://designyoutrust.com/wp-content/uploads/2012/09/JR_insideout_HongKong.jpg
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https://edocs.uis.edu/Departments/LIS/Course_Pages/LIS/photos/JWCSW/big/Skyway_across_Gloucester_Road.jpg (23.02.2014)
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http://upload.wikimedia.org/wikipedia/commons/1/1c/HK_Central_Cochrane_Street_Central-Mid-Levels_escalators_1.JPG (25.02.2014)
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http://mark000911.files.wordpress.com/2013/06/scm_news_1-1-nws_backart1_1_0.jpg (25.01.2014)
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https://www.google.at/maps/search/hong+kong+skyline+ifc+wallpaper/@22.2867849,114.1410568,14z (15.05.2014)
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http://www.pland.gov.hk/pland_en/p_study/comp_s/UDS/eng_v1/images_eng/OI23.jpg (23.09.2013)
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