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The Effect of the Thermal Performance of the Forms Inspired by Nature in the Design of Tall Buildings A Case Study of the Tree in Cairo Climate

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Abstract:- The different forms of buildings reflect the diversity of different cultures and schools among the architects of different ages. The geometric shapes have dominated most of the buildings in ancient and modern times and we see this clearly in distinctive and unique building, which are distinctive signs of some cities including pyramids in Egypt, the study discussed the study of the simulation of nature and its impact of forms and formation of buildings all types and sizes compare them to the thermal performance of buildings. In the practical, the type of high buildings was identified as a study case because of its importance and impact, The research objective is that the shape derived from nature is better in terms of thermal performance, This confirms the hypothesis of research that the shape resulting from nature leads to better environmental and the performance of the thermal compared to many geometric shapes.

Keywords:- *Formation – Tall Buildings - Tree - Nature Simulation - Thermal Performance - Geometric shapes.*

I. DEFINITION

There is no general definition of the tallness of buildings or the number of floors that should be classified as high. The architectural height of the building is measured from the outdoor pedestrian entrance to the top of the building, "According to the CTBUH1, Buildings with 14 floors or a tallness of 50 meters and above can be considered "high-rise buildings"; buildings with a tallness of 300 meters," supertall buildings", and 600 meters and above, "mega-tall buildings". CTBUH1 is measured from the " Large outdoor "to the lower architectural part of the Building, including towers, but not including antennas, signs, flag poles or other technical equipment.

Fig 1:- Insurance Building, Chicago, USA, 1885

Humans have built huge structures such as temples, pyramids, and cathedrals throughout history. Humans have always pushed from the limits of nature in their old quest to rise, from the ancient tower of Babylon in ancient times, purported to be designed to reach heaven, to the tallest building of the day. Today skyscrapers are built as symbols of power, wealth and prestige because they are huge buildings.

[1] CTBUH, Council on Tall Buildings and Urban Habitat, Illinois Institute of Technology, S.R. Crown Hall, 3360 South State Street, Chicago, Illinois, USA, www.ctbuh.org.

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Today, almost no big city of high buildings. as such, it is present for international symbols such as Burj Khalifa, Petronas Building, Taiba Tower and many more. High buildings have become a source of technology, and have changed the concept of a modern city. In spite of the fact that high buildings are far from the large extent of the city's current life, in general, these buildings can be an inevitable feature of urban development.

In the past, the forms utilized in the design of high buildings were constrained but existing, there is freedom in design of these buildings significantly, along with sophistication, technology and contemporary. At present, advanced computer technologies have been used to construct high-rise buildings in an attractive and exceptional manner that has not been used before.

There are several factors that helped in the construction of high buildings and their development and innovations in several areas, including: " Materials, construction techniques, operating systems (mechanical), structural systems, and analysis", but at the same time, the increase in height of buildings makes them vulnerable to wind and side loads brought about by the earthquake and the negative effect on the environment.

In designing the genuineness of high buildings, being an important symbol of the city is usually very important. We investigate the hallmarks of most skyscrapers which we believe to be fairly successful reflecting these concepts with the rise of the building and the importance of current innovation.

➢ *The following are mentioned as prominent designs:*

The following projects are selected for different forms already built in the cities of Hong Kong, Dubai, Riyadh, Shanghai, Frankfurt, Shanghai, and different climates at various heights. Here we see the architectural interest in choosing the right shape for hot, hot, dry, warm, mild, rainy and cold climate. For function, climate, thermal and environmental performance.

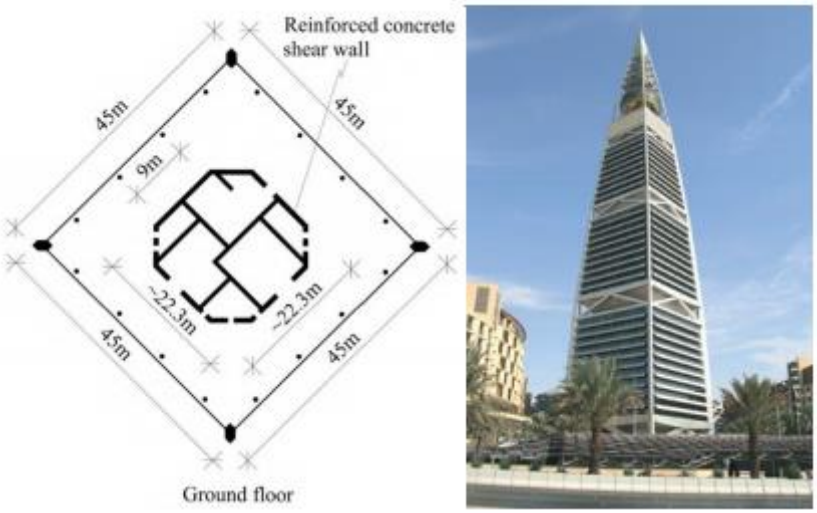

Fig 2:- Al-Faisalyah Center, Riyadh, Saudi Arabia, 2000

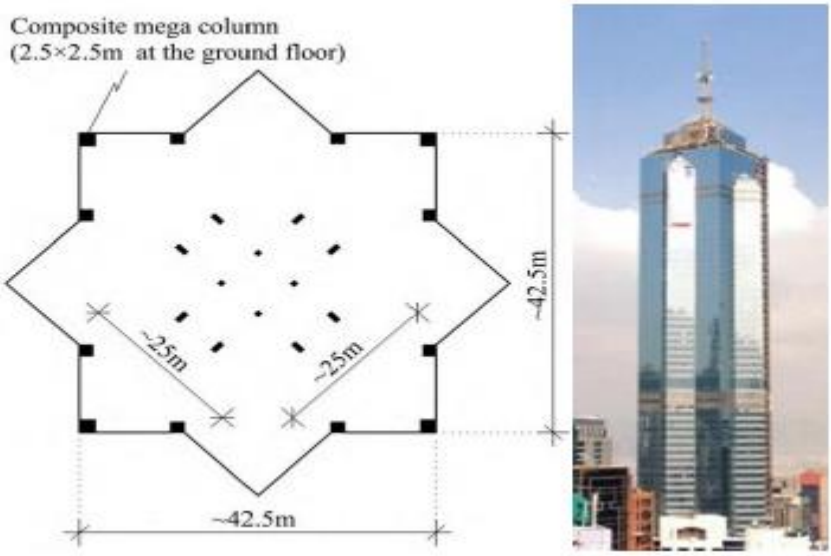

Fig 3:- The Hong Kong Center, China, 1998

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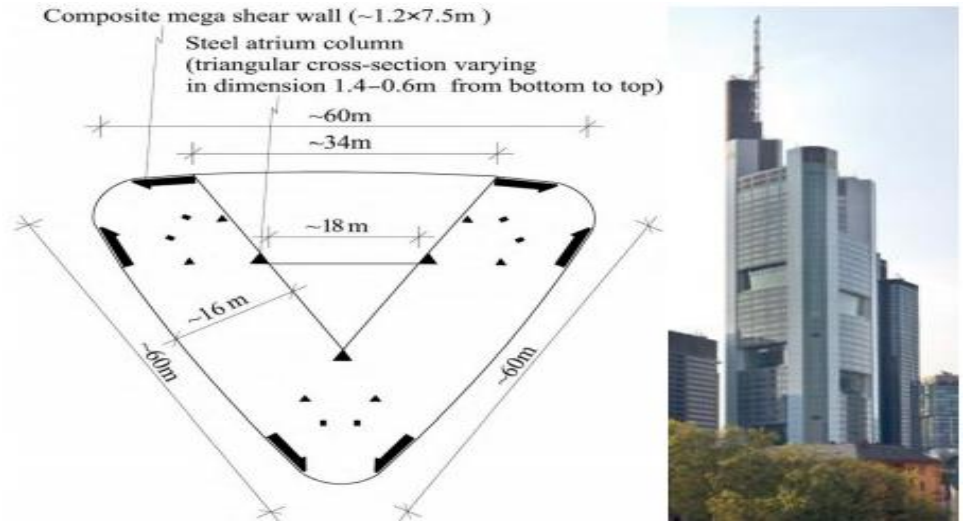

Fig 4:- Commerzbank Tower, Frankfurt, Germany, 1997

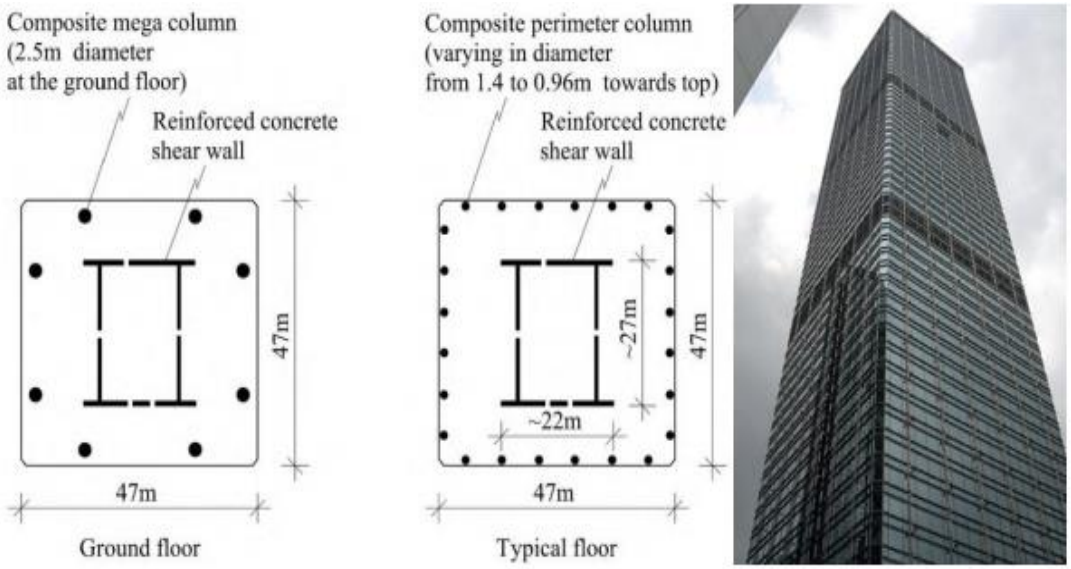

Fig 5:- Cheung Kong Centre, Hong Kong, China, 1999

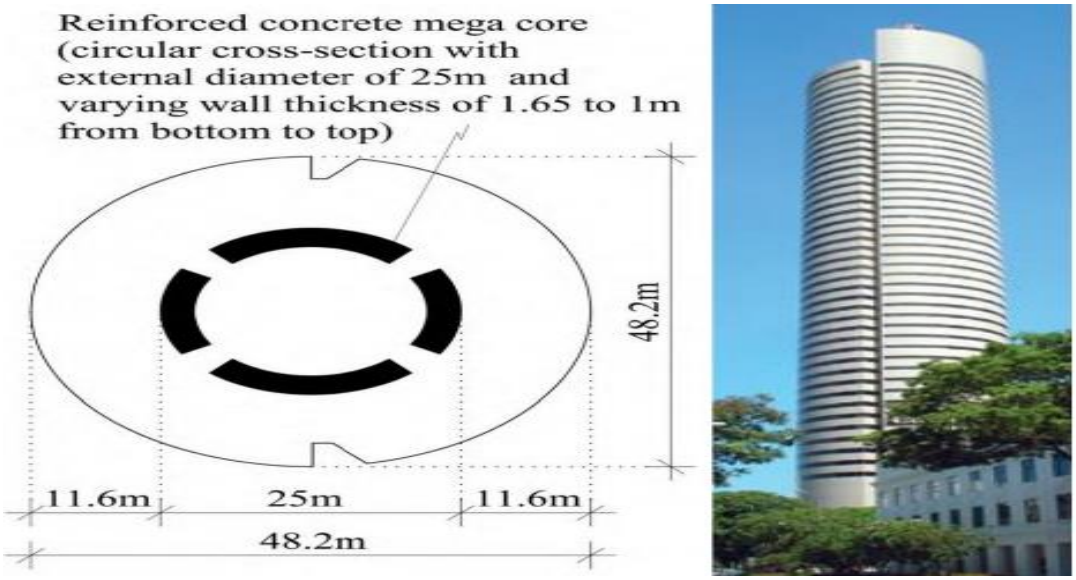

Fig 6:- Shenton Way, Singapore, Singapore, 1986

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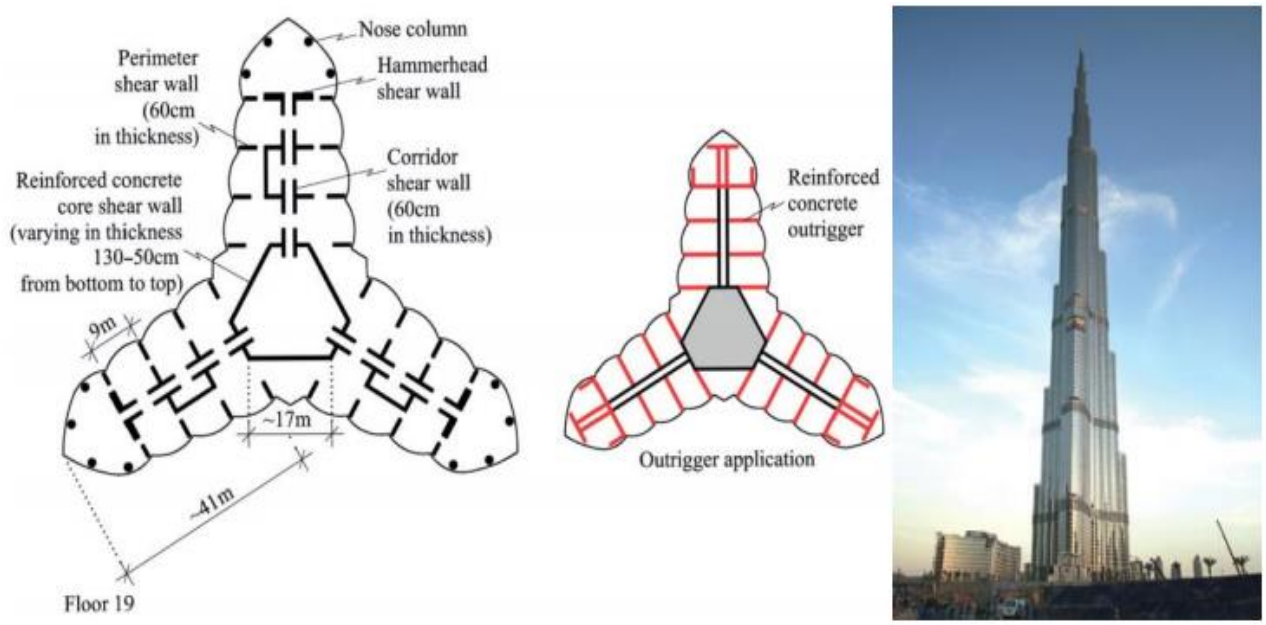


Fig 7:- Burj Khalifa, Dubai, U.A.E, 2010

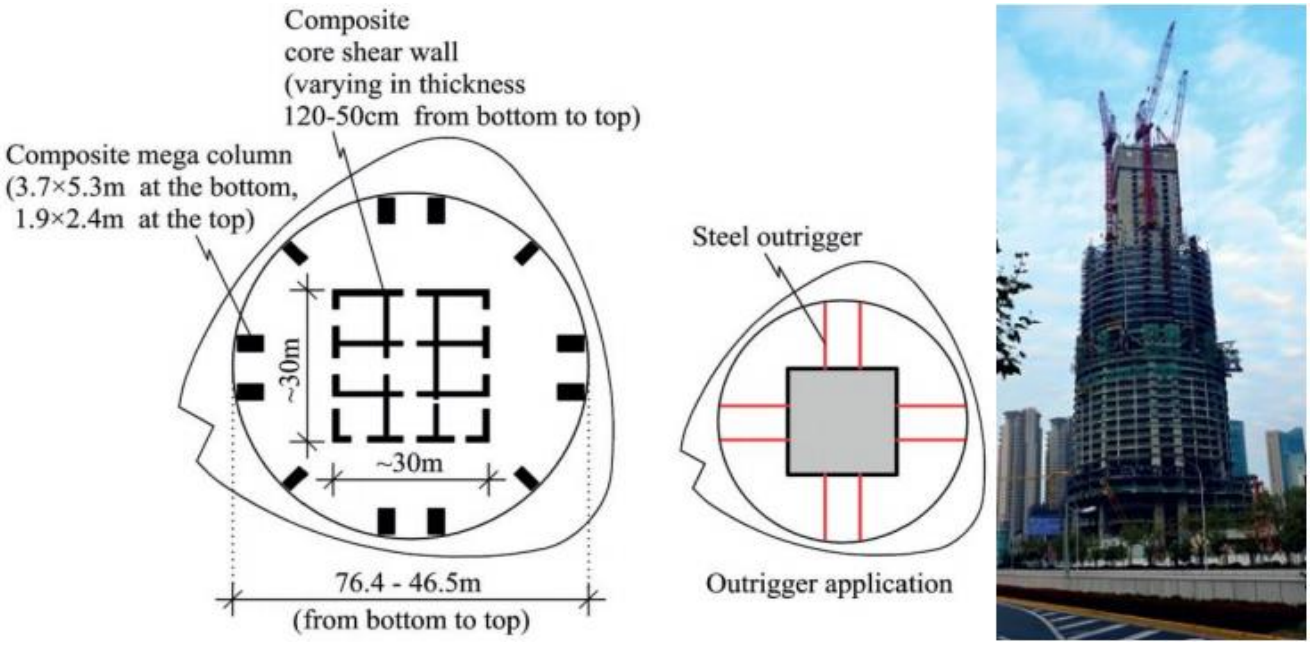


Fig 8:- Shanghai Tower, Shanghai, China, 2014

[2] Halis Günel and Hüseyin Emrellg, **Tall Buildings Structural Systems and Aerodynamic Form**, Mehmet in 2014 Mehmet, Routledge 2 Park Square, Milton Park, Abingdon, New York, NY 10017

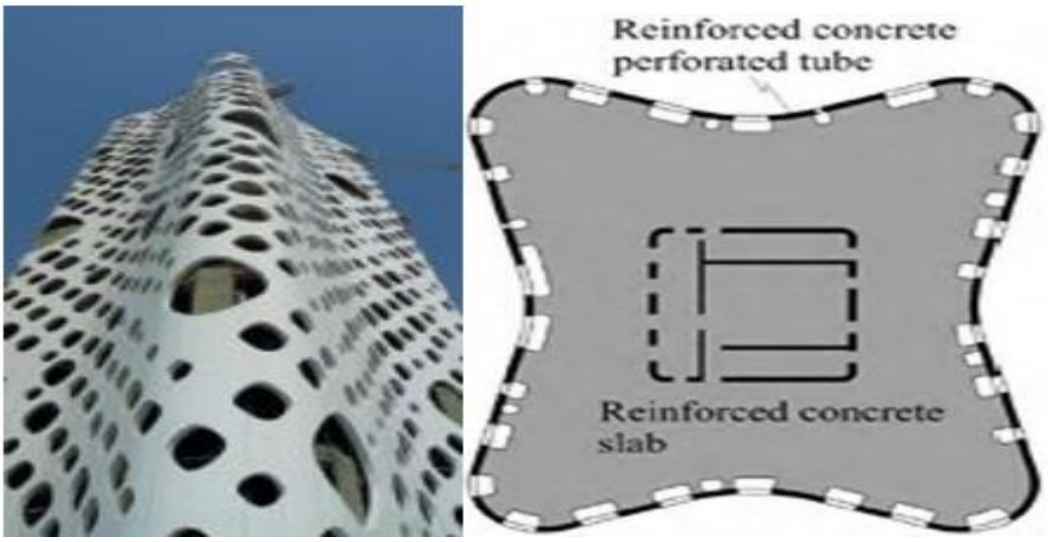


Fig 9:- O-14, Dubai, U.A.E, 2010

Along these lines, in the persistent race of rising, the highlights of urban communities are molded in non-conventional structures. 2

II. PRINCIPLES OF BIOLOGICAL SIMULATION OF THE SAMPLE IN ARCHITECTURE

Architecture has always taken natural forms. The building can refer to a certain organic form, yet none of the advantages that can lead to efficiency or technology may appear. Therefore, the form of an organic building or of nature may not be merely formal or functional in proportion to the function and type of building or city climate, mechanical systems or environmental and thermal performance as a direct result of the natural principles of design and construction. Who takes inspiration from them? Examples of the shape of the building in the section are presented above examples not because they are said to represent models of organic or simplified structure, but because they are appropriate examples of curved shapes that challenge nature in natural engineering or regulatory rules. 3

Fig 10:- Fab Tree House ,South Elevation ,Terre form One.2017

III. CASE STUDY

The study area was chosen as the city of Cairo because of the city's future in high buildings and also for the existence of a challenge in its warm climate For the study of shapes taken from nature, the tree was selected as a simple form and compared to several different geometric forms to study the average temperature and also humidity by the program of Grasshopper using the analysis of Ladybug and Honeybee In this study, fixed measures were made. The height is 100 meters and the area is 900 meters square, so that we can compare the variable, which is the shape The results were

selected as follows (tree - square - rectangle - triangle - circle - oval - star - hexagons) and after the work of analysis on the city of Cairo proved the results valid hypothesis that the form taken from nature leads to better performance in terms of heat and humidity From these results Make sure the design is important simulated nature as an important science and must be included in the architectural design, especially the design of high buildings and that the tree is only a model of many models .show table (1)

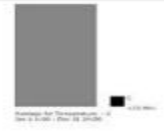
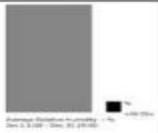
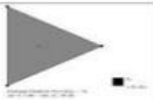
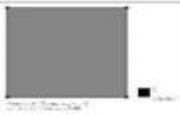
Form Cairo	Temperature	Average Air Temp.	Humidity	Average Relative Hum.	3D	Note
Rec. Annual		Jan 1 1:00 Dec 31 24:00 **<23.99<** C		Jan 1 1:00 Dec 31 24:00 **49.59 %**		2
Star Annual		Jan 1 1:00 Dec 31 24:00 **<37.87<** C		Jan 1 1:00 Dec 31 24:00 **70.93 %**		8
Hexi Annual		Jan 1 1:00 Dec 31 24:00 **<24.04<** C		Jan 1 1:00 Dec 31 24:00 **49.97 %**		3
Tringle Annual		Jan 1 1:00 Dec 31 24:00 **<31.60<** C		Jan 1 1:00 Dec 31 24:00 **70.55 %**		4
Tree Annual		Jan 1 1:00 Dec 31 24:00 **<23.83<** C		Jan 1 1:00 Dec 31 24:00 **50.88 %**		1
Square Annual		Jan 1 1:00 Dec 31 24:00 **<31.88<** C		Jan 1 1:00 Dec 31 24:00 **70.38 %**		5
Circle Annual		Jan 1 1:00 Dec 31 24:00 **<35.10<** C		Jan 1 1:00 Dec 31 24:00 **92.54 %**		7
Oval Annual		Jan 1 1:00 Dec 31 24:00 **<34.13<** C		Jan 1 1:00 Dec 31 24:00 **68.94 %**		6

Table 1:- A comparative table for different forms of heat and humidity.

IV. RESULTS

- The shape follows the function. In this sense, the shape derived from nature serves the function in terms of heat and humidity.
- The shape of the tree is a regular random form is good in terms of tendencies and construction and the rest of the systems such as wind resistance, ventilation, and lighting, and it is necessary to conduct a practical analysis of all these systems and know the extent of integration with some.
- The geometric forms are the product of the architect's understanding and state of design, but it is unknown whether successful or unsuccessful for thermal and environmental performance.
- Consideration ought to be paid to the design of high buildings in terms of shape and environmental performance, as they have a significant impact on the environment. • The forms derived from nature are appropriate to the environment in them, so look at nature as a teacher.
- For the Cairo climate, the rectangular shape after the tree is considered a successful form in terms of thermal performance and relative humidity followed by the hexagonal shape, then the triangle, then the square, then the oval, the circle and finally the star shape.
- There is a similitude between the good shape and the shape of the tree and the shape of the star almost to be close, but the tree in its natural form and regular irregularity achieved the highest efficiency in terms of heat and from here it must be noted that it is not necessarily taking shape and stripping cannot change.

RECOMMENDATIONS

- It for what is appropriate for the city's climate so as to have higher efficiency.
- It is necessary to use specialized environmental architectural programs to study and analyze buildings, especially high buildings, to avoid future mistakes. • We must take into account nature's strategies because it is the teacher and because nature resists climate and adapted to it.

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