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Underground Architecture

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Abstract: Humanity has a long history of utilizing underground spaces. Back deep in history people lived in caves and underground spaces while using the above tracts of land for growing their crops.

Drawing upon mankind's experiences in the past, we can see that underground constructions are a future need. This kind of architecture has achieved the principle of containment through covering with natural soil at least three sides of the building. All examples in this study have one thing in common: The plans are hidden underground in order to correct the relation between the need to build and the necessity of protecting the environment. Hence, burying the construction helps preserving the open spaces. And consequently, analyzing causes of burying the constructions helps in reaching suggestions and recommendations over the best methods to develop those constructions and presenting new applicable models.

First chapter deals with the underground spaces as due to natural factors that led to the creation of caves or underground spaces. Soon after, man started using those spaces either for religious purposes (burying temples), or to acclimatize with the harsh conditions of weather (holes dwelling in China and Mitmata dwellings in Tunisia), or for protection against enemies (underground military bases; or Kapadochia in Anatolia for the followers of the new religion. Since most of the above mentioned reasons have lost their logical justifications in the 20th century, new needs such as energy conservation and environment preservation has given underground constructions their new lease of life. The first chapter, also touches upon some futuristic visions suggested by some planners and designers with an aim of creating a complete city underground, as they believe that living above ground would gradually be rendered difficult due to the ever mounting pollution.

Building upon the aforementioned researches, planners categorized some concepts on underground architecture which has developed in several fields like function, lighting, and depth. Due to these developments, new elements have emerged, which should be taken into consideration when studying underground constructions (this is covered in the second chapter).

Through drawing upon the historic experiences in Aleppo city (Chapter Three), and understanding the nature of the old and new solutions and their compatibility with domestic realities and conditions, and after casting a keen look at the state of the underground constructions in the city of Aleppo, some suggestions and solutions can be proposed with an aim to develop this kind of architecture and make it compatible with modern methods and available means.

Key words: underground facilities, environmental benefits

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1. Introduction

As Architect Malcolm Wells' famous statement:

> If the architecture that we know are positioned above the Mother Earth, the underground architecture positioned between her arms (Carmody, 1993).

Humanity has a long history of utilizing underground spaces. Back deep in history people lived in caves and underground spaces while using the above portions of the land for growing their crops.

Looking over the mankind's experiences in the past, we can see that underground architecture is a future need. This kind of architecture has achieved the principle of (containment) through covering with natural soil at least for three sides of the building. All examples in this study have one thing in common: The plans are hidden underground in order to correct the relation between the need to build and the necessity of protecting the environment. Hence, burying the construction helps preserving the open spaces. And consequently, the analyzing of causes of burying the constructions helps in reaching suggestions and recommendations over the best methods to develop those constructions and presenting new applicable models.

2. The Importance of Underground Architecture and Its Evolution

Underground facilities were caused by the elements of nature that created the sheltering craters and caves, the growth of these facilities was to meet several requirements, including religious beliefs (which called for the buried temples) or adjusting the climate (such as halls for the Chinese or dwellings of Mattmata in Tunisia) or the aim of protection and safety (such as military bases or underground city of Cappadocia) [1], the hiding is because of fear of a new religion or protection in case of war), and the continued use of the underground facilities in the modern era is either to keep up with population growth or for the protection from natural disasters or for energy conservation in addition to a technology that has helped to increase the used depths and other characteristics of the underground facilities which encouraged the continued use of those facilities (Carmody, 1993).

2.1 Historical Uses of the Underground Facilities

The overlook of the underground architecture throughout history gives us a true reflection and a clear expression of different changes in the communities. The beginning of Underground Architecture was through natural caves in the rocks or digging beneath the surface of the earth, so the steady growth stage of the underground facilities is taking advantage of the caves and spaces which are buried in the soil or inside rocks for other uses than housing, such as mining, worship and storage.

The beginning of Underground cities was for hiding in case of war or a new religion or for hiding people, animals, tools and crops with attention to the size of the underground city that it should not grow at the expense of agricultural land (Carmody, 1993).

2.2 The Twentieth Century Uses of the Underground Facilities

Previously we found that the underground facilities expanded for thousands of years, and have become an important part of the evolution of architecture, where developed underground facilities in some countries such as Japan and China are excellent, In Japan, for example it was possible to build a big number of underground floors. As the underground metro has become a model for innovation and renewal, there are also laboratories, markets and museums, garages and commercial buildings .... and other underground facilities that have constructed in the

twentieth century (Golany, 1989).

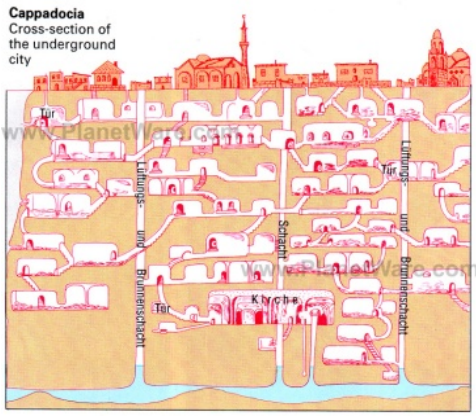

Figure 1 An Imaginary Draw of Underground City in Cappadocia-Turkey Which Shows Wells that Have Been Used for Lighting and Ventilation

Figure 2 Matmata in (Tunisia), A Whole Society Is Living inside Dwellings Carved into the Rock

New requirements have been raised in every age to increase the involving and influencing elements of the design of underground facilities (such as design methods with the consideration of the nature of the site) and the evolution of systems, building materials,….so Historically we find that the underground buildings are totally dependent on the local environment, the majority of these buildings were built with brick, which is made from either silt or backfill from digging operations “hay” or some herbs (Golany, 1989), yet the local environment did not apply enough materials, therefore the use of various kinds of wood, iron, tiles, cement and bricks started depending on the type and of the building. And there are several definitions for underground facilities depending on the study of its historical development and modern uses.

Studies are still ongoing to determine accurate categories of underground facilities because the look for those facilities differ for an architect or planner or mining engineer. Railways encouraged people to dig tunnels to minimize these roads above the Earth’s surface where the back of the first subway in Moscow in 1930 (Hall, 2009). At the duration of the last ten years of the twentieth century (from the seventies to the end of the century) began to pay greater attention to the environment and energy conservation, where the use of underground facilities, one of the ways to implement energy conservation, and new uses have been appeared for underground facilities such as commercial markets, museums and educational buildings, libraries ..... etc..

Forms of underground facilities help to develop the public space in the cities and the efficient use of the Earth's surface through the development of these forms in urban design (Golany, 1989).

Figure 3 Water Temple in Japan is Buried under the Ground: Going Down is by Stairs Which Are Cut From the Elliptical Basin

Figure 4 Preservation of the Open Space at the Campus of the University of Michigan Using Burying the Library around Triangular Patio

Figure 5 The Site of the Museum of Tadao Ando: Nothing Arise Except Patios Which the Showrooms Are Bounded around Them

2.3 Some Visions of the Future of the Underground Facilities

Some fictional and theoretical studies of the underground facilities have been proposed as a solution for congestion and environmental problems in many urban areas in several countries, the most notably examples are in France and Japan, and most of these studies focused on the underground cities.

Scientific fiction' writers Focused as well as architects and planners on the importance of using the underground spaces through visions of the future of the underground facilities (Taylor, 2001).

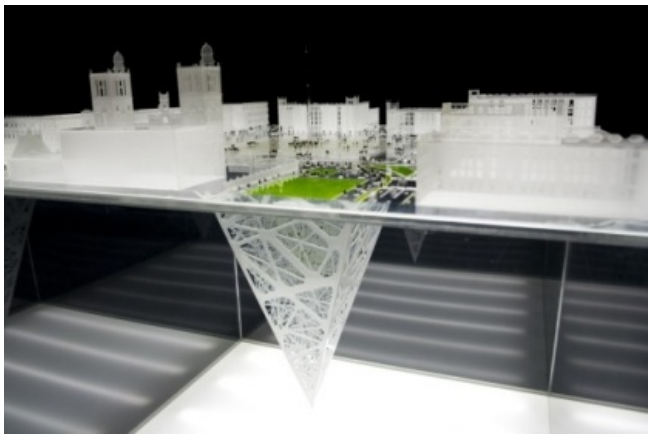

Figure 6 Futuristic Study for A Land Scraper Will Use the Wind And Solar Energy to Apply Electricity in Mexico City

Figure 7 Japanese Aspires For Several Centers of the City Which Integrated with the Metro Lines Where Most of the Functions of the City Will Be Underground, Surface Area Remains Available for Trees and Parks

Table 1 Types of Underground Facilities Depending on Depth

Term	Depth (in meters)		
	Buildings	-Religious Uses -Transportation	Mines
Low depth	0–10	0–10	0–100
Medium depth	10–30	10–50	100–1000
Deep	D > 30	D > 50	D > 1000

3. Environmental Characteristics of Underground Facilities

New needs such as energy conservation and environment preservation give underground constructions their new Meaning. The first chapter, there are some futuristic visions suggested by some planners and designers with an aim of creating a complete city underground, as they believe that living above ground would gradually be rendered difficult due to the ever mounting pollution (Vale, 1991).

3.1 Planning and Design Considerations for Underground Facilities

Considerations of underground facilities started through the use of courtyards to provide natural lighting and renewable ventilation but these elements have been evolved and adjusted by certain methods. We Can continue to develop the design considerations according to the desired goal, for example, there are special ways in the enforcement of the external lighting, techniques such as video and artificial lighting began to use in design study of underground facilities.

Underground construction is not easy, public underground facilities need to apply the functional aspects such as the number of entrances and enough study for the surrounding and emergency exits ..... In addition, the study of aesthetics to those facilities. The study of the plan and shape of underground facility has to create an atmosphere of an internal space which compensate the lack of windows (Taylor, 2008). And because of the importance of creating a clear image of the facility which is hidden under the line of sight, so we need to clarify the boundaries of the facility and the exposed architectural elements in the site to be able to recognize this hidden building.

We should hide services of these facilities such as (ventilation shafts-emergency exits), so it should be a separation between the pedestrian entrance and vehicle and service accesses and as much as possible. Also a secured entrance has to be designed so that a person can distinguish it from far distance to allow reaching the main entrances of underground facility (Brebbia, 2008).

3.2 Environmental Benefits of Underground Facilities

If We want to re-solve problems which are related to the urban population density and limited space on the land we must have a development of underground architecture because it is a part of the eco-friendly architecture. We can integrate underground design with sustainable environmental design, because it proved the efficiency of energy use, and it’s less impact on the surrounding environment.

One of the reasons for the need to build underground is because of the increasing need to reduce the lack of green areas, for example, when you need to find a building’s extension for an existing building and in the same time we do not need to interfere with the existing landscape so the best way is to build underground (Taylor, 2001).

So we can summarize environmental benefits of underground facilities as follow:

The evolution of the architecture being underground in a parallel line to the environmental design, and the relation between each other is a remarkable issue. There are different interpretations of phrases (green buildings) and (sustainable design) and (loving-environment Architecture), but it is more generally accepted as a standard phrases in the leadership of all of the above statements is (Energy and Environmental Design).

In ancient times there were natural caves which were effective solutions to the need for shelter and the lack of construction materials and techniques, these shelters provided automatically a number of environmental benefits such as protection from climatic conditions and natural occurrences. Conversely to the historical developments, the recent examples of buildings under the ground were not automatic solutions (Vale, 1991), but Because of certain goals (crowded urban zones often do not provide environmental protection and conserving

energy which we use it for heating and cooling in buildings). The importance of these things will arise in the future. So the Burying buildings underground offers additional benefits compared with original buildings such as heat insulation, calm-hurricanes and earthquakes resistant, ... some of us will be surprised from underground life, but it is possible to become certified issue in the design of the future.

Awareness of the environmental movement began to increase during the last ten years, and Architects started looking for ways to protect and conserve energy and reduce the impact of buildings on the natural environment in order to save natural environments and produce comfortable for people (Coles, 2007).

The underground facilities are of eco-friendly style ... in terms of:

(1) They have very effective role in protecting the surrounding environment.

(2) Conserving energy which we need it for the process of heating and cooling, and this is resulting from the natural earth layers (which act as an high thermal efficiency insulator), which provides approximately 60 to 80% of energy consumption.

(3) Visual impact .... because of its adapting with the earth and nature.

(4) The provision of green areas ..... and give a big opportunity to expand the green areas above the surface of those facilities.

(5) Increase the efficiency of land use and benefit of the spaces under the earth's surface (Vale, 1991).

4. Implementing Underground Facilities Characteristics in Aleppo City

The local experience in the city of Aleppo in underground constructions is limited to few projects. Up till 2012, no interesting has been shown in new designing solutions which are compatible with planning needs.

4.1 Monitoring Underground Facilities in Aleppo City

Historically, the underground spaces were used in the city of Aleppo for different purposes: for hiding-warehouses and to link the markets with some important buildings in the city. The lack of open spaces in the city encouraged the use of underground buildings. The geological area of Aleppo City makes it available to earthquakes, and this makes us take care of the underground Buildings because of its resistance for natural disasters (Hadjar, 2000).

We can arrange historical and modern uses of underground facilities in Aleppo city within the Table 2.

Table 2 Evolution of Underground Facilities in Aleppo City

period	Underground structure type	Historical use	Modern use
Neolithic7000 BC	caves	Residential	
Belonged to the Roman Era	Aleppo's castle basements	Shelter from the storming of the enemy	
	Tunnles under the old city of Aleppo	-Pull Water to wells of the old city of Aleppo -connect the citadel with the Alsouq and the districts of old city	
786 AD	Nahaseen Bath	Public Bath	Public Bath
944 AD	Citadel prison	Water store-prison	Tourism
2001 AD	parking		Reduce traffic
	Car tunnels		Solve transportation problems
	Pedestrian Tunnels		To ease passing the wide streets
2010 AD	Library under the courtyard of Umayyad Mosque		No enough area above the ground at the old city of Aleppo

Finally, we hope that we have been succeeded in throwing light on the reality of underground facilities with adequate information for such buildings to draw attention to the importance of these types of buildings and its environmental benefits to make useful from it in our similar futuristic studies.

5. Conclusion

(1) The idea of using the underground facilities have emerged from ancient times in several places of the world, the continued use of these facilities in the modern era is due to several factors, including keeping up with population growth or for the protection against natural disasters or to conserve energy and other characteristics of those facilities.

(2) Underground facilities have been developed because of the need of it after the seventies of the last century where those facilities expanded vertically underground until it reached to what is now called land scrapers.

(3) There are many architects such as Malcolm Wells and Bill Lishman and others who decided to remove the gap between above and under the ground to highlight the environmental benefits.

(4) Underground architecture is an attempt to correct the relationship between the human need to the construction and preservation of the environment and energy.

(5) Door remains open to the ambitions of architects to create new ideas to improve the performance of underground facilities.

6. Recommendations

(1) Create public garages or public buildings under public parks and squares or yards, so as to keep open spaces within the city of Aleppo as an outlet for people (Saadallah Algabri yard-paved arena in Telal).

(2) Sending recommendation for Municipalities to take care of neglected land and sites to be as an open yards or gardens with underneath parking.

(3) Advising companies to design public buildings such as commercial or cultural buildings (museums or theatres) as underground facilities.

(4) Following the methods of modern construction allows the designer to improve underground buildings which we are able to develop and modify them, especially in the areas of a growing population.

(5) We need to provide new models of underground facilities that are essential to maintain the environment and here comes the role of the architect.

(6) Parking occupies space from the streets as well as they cause congestion and obstruction, which requires underground garages in the government and private companies.

(7) It is very important to involve physiologists and socialists to enhance the people's awareness about the underground Architecture and encouraging them to use it.

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