

DEVELOPMENT OF SUBSURFACE SPACES BY SUSTAINABLE URBAN DEVELOPMENT APPROACH

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Abstract.At the moment, underground spaces organize a small part of the urban areas of metropolises. What has been used as underground spaces in these cities is the spaces for intracity communication and transportation, such as tunnels, transport lines and metro stations. This is while, the wider and greater application is possible to plan to underground spaces due to the high potential in solving the earth's problems. Contrary to current imagine at present, underground spaces are not only used as communication spaces and its capacity can be used in different applications such as recreational (sport and commercial development places and,.....parks) , markets, libraries, and (.....,cultural) museum , Cultural center, cinema (and service) parking. The use of underground spaces is one of the newest ways in urbanism to achieve sustainable urban development. This approach, while taking advantage of underground spaces, also helping to solve urban problems, such as lack of space, urban transportation and environmental problems. The purpose of this paper is to study the indices, criteria, advantages and disadvantages of developing underground spaces, and the effects and benefits of using them to achieve sustainable urban development. Documentary- library sources, and internal resources, and "descriptive-analytical" research, the new and up-to-date international articles has been used to methodology, as well as the research literature.

The results of the research show that considering to high capacity of underground spaces, in addition to being able to use as transport and communication, it is possible to Transfer many usages to underground by using technology and modern technology which can help to solve many of today's urban problems and realize sustainable urban development.

Key words: underground spaces, sustainable development, Urban Design, urban Infrastructure

1. INTRODUCTION

Throughout history, human beings have always a special looked at the underground and mountains , and has considered it as a safe place to live, and everywhere felt threatened by external and environmental factors refuge d to under the ground. Also, there are many evidences both objectively and in historical and religious texts to prove this. The widespread growth of human civilization on a global scale has had a dramatic impact on human life and countries are seeking to the better living standards, so This case is affected by three following main trends: 1. Transforming agricultural land into urban structure; 2. Increasing urban population in the world; 3. Expanding environmental protection concerns. Using of subsurface spaces provides an opportunity to improve these three trends. For a number of reasons, several decades now, the new dimensions of underground and subsurface spaces utilization have been opened up and attractive to humanity.

Increasing population growth and urbanization development have urban communities confronted to serious challenges and problems, so that, Base on United Nations report, in the year 2014, 28 metropolises in the world have population more than 10 million people (12% of the urban population in the world) or it's predicted that the number of cities with over 10 million population would be met to more than 41 cities, By the year 2030. Due to the lack of land and raising the price and the consequences of it in metropolises in the world, this challenge is serious and definitive. Therefore, the attention of the urban management is justified and obligated for using sub-surface spaces to urban organizing. In countries like North America, European countries such as Norway, Sweden, Finland and Asian countries, especially Japan and China, in the past and present, there has been extensive using of subsurface spaces. Underground spaces have significant advantages than surface spaces. Protection against Unpleasant climatic conditions, such as Atmospheric rains, storms and intense sunshine, are the most important positive aspects of underground buildings. [4] Urban underground spaces have many applications such as saving (food, water, and oil, and industrial goods, waste), industry (power plants), transportation (railways, roads, and pedestrian tunnels), welfare services and communications

(water, gas, electricity cables, public application (shopping centers, hospitals, and civilian defensive structures) and private and personal usage (car parking). [5] Sustainable urban development, considering the use of sub-surface spaces, is one of the main concerns of urban planners and architects as designers of these spaces. Urban planners by defining the applications for underground spaces and architectures by designing the buildings have been trying to help this approach to be developed. But, this question would be appeared that in sustainable urban development view, what is the positive aspects and advantage of using this places. At present, underground spaces have occupied a very small part of the city's area, that usage of these spaces is more related to intracity transport, but it should be noted that urban underground spaces can be used more widely. In addition to transportation, these spaces can be used as applications like services, recreational, sporting, health-care, security, and even cultural. [6] Therefore, the present paper studies on alignment of developing these spaces with Sustainable urban development by analyzing and examining underground and subsurface spaces development?

2. UNDERGROUND (SUBSURFACE) SPACES

It's a space that has been used in various climatic, security, economic, and security purposes, since the past to contemporary? So that all or part of this is located in underground and in lower level of the ground. [7] The urban spaces are called public that are designed and built in lower levels of the earth. Such space should also have the quality of urban spaces, namely identity, readability, sustainability, vitality, safety, security, efficiency and diversity, walkability, and ease of access, unity and integrity, and visual proportions [8] Locating some urban uses: Providing the possibility of locating the uses and services which couldn't be established on the ground for reasons such as lack of insufficient space or incompatibility.

3. SUSTAINABLE DEVELOPMENT

Sustainable urban development theory is the result of Environmentalist discussions on environmental issues, in particular the urban environment that is provided following to the (sustainable development)

theory to support the environmental sources. Sustainable Urban Development is needed to identify environmental limits for human activities in relation to cities and matching the design methods in this theory is the topic of maintaining resources for the present and future through the optimal use of land and involving the limitations. Sustainability can be understood as the result of the rational development of a new awareness about global environmental and development issues. Sustainable urban development is ecologically formed as a dominant pseudo-paradigm in developing urban strategies in response to socioeconomic dissatisfactions and its initial indications for the urban development polices was

green space maintenance and water purification, preventing of air pollution and reducing the waste production at the local level. [10]

4. PHYSICAL CHARACTERISTICS OF THE SUBSURFACE SPACE

Urban underground spaces have natural characteristics or features, so that a special attention has been devoted to them. These features, in many cases, caused to save a lot of urban expenses.

Table 1 provided the most important characteristics:

Table (1) Basic Characteristics of Underground Space [11]

Characteristic	description
Insulation	Underground spaces are not so much affected by external factors, and their impact on the outer environment is less than the facilities on the ground (like sound)
Temperature stability	There is no need to heat or cold, many underground facilities do not require to temperature adjustment
Protection	Underground spaces have a limited connection to the outside and the flow or movement through these communication areas is easy to control
Floodwater vulnerability	Floodwater may cause the severe and unpredictable damage to underground structures, such as high surface structures which is destroyed by water weights
Flexibility against earthquake	Deep underground structures are less damaged against earthquake than ground-level structures
An opportunity to stay in close to available facilities	In urban areas, surface space is often dedicated to valuable constructions underground space is the only position to new facilities in required area

5. THE BENEFITS AND ESSENTIAL CAPABILITIES OF SUB-SURFACE SPACES

Effective use of land and improvement the environment: Utilizing of the underground space potential would be caused to use ground-level spatial levels for other uses such as recreational and green spaces. For example, the Released level of land and ground- level surface is used for recycling and walking. In addition, the underground spaces have a potential to hide the unpleasant views and unlikely spaces such as cars parking and highways.

Economic: Underground structures usually require more initial investment during the construction period, but they would have lower maintenance costs in compare with ground-level structures with similar performance.

Environment: Underground structures usually have a negative impact on the environment during construction, but they have many environmental benefits during their activities. The performance of Urban Underground spaces has a great potential to Sustainable Urban Development.

Underground space allows cities to be more compact, so, confront with urban disorder, the level lands are remained for natural environment. Urban dense structures also make it possible to use the Fuel better.

Society: Urban spaces are generally allocated to public purposes. The personal use of urban underground areas is relatively small, and are like the private parking of cars and underground storage, in size. [5]

The essential capabilities of underground spaces are including as below:

- 1- A place to be hide and hide and secrecy
- 2- Source space to embedding objects or required uses.
- 3- Protection (Human and his properties, food and feed storage)

4- Source of materials (extracting and preserving the resources

5- The source of energy for heating the earth and saving energy

6- Groundwater source (storage, transfer, extraction)

7- Temperature stability and environmental equilibrium

8- somatic and physical stability (against earthquake, vibrations and storm) [7]

6. THE NECESSITY OF USING THE SUBSURFACE SPACES

Underground construction is based on the principles of sustainable development, in order to minimize environmental stresses, save the energy consumption, increase the various efficiencies in urban structure, reduce the needing of local transportation, facilitate and increase public services, and protect the urban landscape and Cultural Heritage. Environmental rules and sensitivities in recent years have had a positive effect on underground spaces development, it is why using them is growing rapidly in the world. The researches carried out in this area show that the reasons for this issue in different countries are various, but the similarities are also observed. The reasons of increasing the attentions to use the underground spaces are:

- Topographic conditions, such as communication routes in the mountainous area or under river crossings.
- Saving Energy Consumption by using fixed humidity and temperature in Underground Spaces
- Protecting against natural disasters such as storm, flood and vibrations of earthquake.
- More safety due to limited access points and controlling them
- Environmental protection by reducing the destructive effects of ground-level constructions and

maintaining local natural conditions, vegetation cover, Animal Settlement and...

- Reducing external undesirable effects in compare with ground-level constructions

- Reducing the cost of performing the underground spaces by developing and improving the design and construction methods [11]

7. DIFFERENT ASPECTS OF UNDERGROUND SPACES EFFECTS

1. **Framework:** It addresses to the issue of scale and proportions, and considers the physical Identity and visual attractions.

2. **Functional:** it considers different areas of activity and space usage, such as employment, housing, technical infrastructure, and their required depth in order to quality and efficiency upgrading of the urban environment.

3. **Transport and Traffic:** examines distance and accessibility to metro stations and also to traffic congestion in different regions.

4. **Socio-demographic:** considers the factors like social dynamism, social status, and demographic density by examining and studding on population structure, employment rate, income level, facilities level, housing type, per capita urban, family and population dimension in level unit.

5. **Environmental.** Addresses to issue from the perspective of making the environment capacity and countering atmospheric problems, keeping beautiful the surface of the ground, reducing the density in surface, preserving plant and animal life and livelihoods, reducing air pollution, reducing noise pollution, reducing the density .

6. **Technical and performing:** Addresses to the technical characterizes and construction method of underground spaces and considers issues such as

analyzing the site in geotechnical, Geologic, Hydrological, Underground structure design perspective in terms of its position and Structural calculations and how to make and perform it.

7. **Economics:** studies on economic Indicators include the local quality of land, housing prices, household economics, and focusing on economic activities.

8. **Management:** pursues numerous goals, including strengthening of managerial and organizational structures for solving the span problems, encouraging urban managers and Institutions and their participation in constructing and utilizing of subsurface spaces, increasing the level of implementation of the project by considering the people participation in performing and utilizing and land ownership and other cases.

9. **Law and property:** addresses to the legal issues of project before and during implementation, and during utilization, and proposes the regulations of projects, such as checking and approving project, also codifies and setts the approval authorities, occupancy of lands and required real estate to recommend to the relevant authorities. [11]

8. EXPLAINING SUBSURFACE DEVELOPMENT INDICATORS

If the development of subsurface spaces wants to be transformed into something beyond a traffic solution, to achieve this goal we should recognize in which field and how much able to use and also necessary to such development.

In this regard, some institutions and organizations, including the International Tunneling Association, Agenda 21 and Tehran's Subsurface Life Development project, have developed standards to Tehran's Subsurface Life Development which the most important of them in 5 areas, framework, transport, social, economic and environmental are provided in this paper in table NO.2.

Table 2: Subsurface Development Criteria [12]

Steps	Criteria	Criteria description
Prevention and preparedness	Decreasing the costs	Allocating Enough budget to determine areas with high vulnerability
	land using management and incidental points identification	Lack of uses distribution density, attention to locating uses with high population density, right distribution of helping centers, a large number of urban open spaces and its suitable distribution
	Urban installation and Infrastructures	Appropriate establishing and locating of resources, pipe networks and installation, and its central control of the and urban infrastructures with appropriate vibrations cod
	City's communication network	Decentralization of traffic nodes in one area, designing the alternative route as a damaged rout, making communication within Sensitive uses, making the availability network hierarchy...
	Attention to human needs	People, Increasing the number of coping methods with preparation problems in order to training and generalization
Confronting	Relief	Temporary accommodation of injured people, medical assistance, shelter and food, emergency arrangements, and etc.
	transportation networks improvement	Prevent to fire spreading, debris removal and passages clearing, operating the emergency routes
	Social activities	Prevent to fire spreading, debris removal and passages clearing, operating the emergency routes
Rebuilding	Improving the spatial structure of city	Estimating the long-term damages and destruction, debris removal and destructed buildings and passages clearing, infrastructure actions, alternative installation including reconstruction of destructed buildings...

	Establishing security and peace	Attention to the people's Protests and controversies, providing security in destructed areas
	Preventing damage to the urban environment	Being careful in collecting and correct excreting of industrial, urban garbage and the materials remained from destruction, prevent of pouring harmful and Flammable liquids, prevent to subsidence and toxic gases spreading, collecting the non-degradable materials and entombing at a suitable location rapidly. Cutting off the dangerous rays quickly.

9. LIMITATIONS OF URBAN SUBSURFACE DEVELOPMENT

Undesirable mental and psychological effects: in underground, the fear of closed space, which is in some people, with the emotion of crushing and asphyxia and Being imprisoned following to loss of any signs and awareness of distance. The Mental illness, claustrophobia, is one of cases of this effects which is due to the fear of being surrounded and being in a closed space.

Ownership and owner rights: Using the underground proposes the legal issues related to property rights, relationships between personal property and the rights of the community. The right of using the basement is often not well defined. However, it cannot be accepted that the ownership of land encompass basement ownership without any restrictions. [13]

10. STUDDING ON WEAKNESSES OF SUBSURFACE SPACES BY SUSTAINABLE DEVELOPMENT APPROACH.

- Debilitation of identity and historical Legibility in historical context, destroying the Identity elements or their foundation in underground
- Vulnerability in some phenomenon of changing the climate such as flooding in urban floodwater.
- Creating the routs and non- walkability nods.
- Creating unsafe, vague and mass of crime, undesirable mental and psychological effects,

Dewatering, poor efficiency in fire cases, pour of unstable and loose layers, Inappropriate ventilation , occurrence of espionage, adventuresome activities, The terrorist operations.

- Visual obstacle and being deprived of understanding of the visual attractiveness of the subsurface space.
- creating an insufficient spaces in terms of accessibility, ventilation and the traffic and the possibility of stopping traffic and lighting systems.
- creating the separated, closed, surrounded and insular spaces
- creating the spaces in inhuman scale and terrifying dimensions and sizes
- rotting the individual's right and owners in developing of subsurface spaces
- Difficulty using for disabled, children and elder people.[7]

11. THE FEATURES OF SUBSURFACE SPACES IN SUSTAINABLE DEVELOPMENT VIEW.

Wellness: Underground spaces with providing favorable temperatures have a positive role in promoting relaxation and spiritual vitality and reducing the anxiety

- These spaces minimize the turmoil and turbulence in terms of visual and audition by separating from the outer spaces.

Climate: In most areas in the world, the sand and soil temperature in lower depth show the moderate

and stable thermal environment in comparison with maximum of surface temperature difference. The moderate and stable temperature of underground provides a good condition to saving and preserving of energy by slight thermal fluctuation. Unfavorable climate conditions: underground constructions are resistant against the hurricanes, whirlwinds, storm, thunderbolt, hail and the other most natural phenomenon. Designing the building to underground is very responsive to many requirements and problems in related to climate such as sustainability against humidity effects on materials.

Fire: subsurface buildings are potentially protected from external fire. The surface of the earth is non-flammable and is considered a very favorable insulator for its underlying structure.

Earthquake: Due to the acceleration of earth movement at the level of subsurface structures are more resistant and take lower effect of the earthquake than ground-level structures.

Safety: Underground spaces are safe from sound pollution, vibration and exposure to radiation. A small amount of upper layers of ground is a very significant obstacle to prevent the influence of the airports and highways noise in underground structures. Vibration and shake amount caused by traffic in routs and highways, trains, industrial and constructional machinery, would be cleared quickly by increasing the depth and distance of its source. Underground spaces are also applied to control the consequences of climate changes phenomenon. Increasing green space and protecting the environment: the use of underground spaces minimizes the impact on nature and brings a relaxed and refreshing environment away from atmospheric pollution, audio and visual by transferring stops and storages to the basement and freeing up surface spaces to create parks and greenery. Underground spaces and underground development problems can be used to compress cities. Reducing the use of land, increasing the possibility of using public transportation systems, as well as common facilities and thermal facilities reduces environmental damages by the help of private individuals. In general, the city and its stability has a meaningful relationship with together. Therefore, developing the lower levels is an option for the sustainable development of the environment and the city. [15]

12.CONCLUSION

By studding on subsurface spaces, it can be concluded that subsurface spaces in addition to advantage, also have disadvantages and obstacles to realization, success and satisfaction and like non-subsurface spaces require a specific process including planning, design, implementation, evaluation, utilization and management. However, building subsurface spaces could be regarded as one of the urban plans, the ruling circles have seen such plans as other land plans and consider its rules as other projects on land, but because of the specific features of such projects, including the interest of different executive agencies, and the lack of 3D Cadaster in country, the projects may be conflicted in underground. It seems that the way of using the urban underground spaces is important to the sustainability of cities. Underground spaces save up energy efficiently, by thermal sustainability and a minimum of heating and cooling requirement which is an important step in the sustainable urban development.

Transferring the infrastructure installation to a common installations tunnel, especially in capital cities, could be an effective step in cities sustainability against the natural disasters. On the other hand, expanding of subsurface spaces would be resulted to maximum use of urban lands. Reducing energy consumption and increasing the economic productivity of land are principles of sustainable development. Considering the sustainable development approach, especially in capital cities and attention to climate, natural, economic, social and cultural conditions can help to improve the quality of environments and cities' sustainability.

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