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MODERN SOLUTIONS TO THE PROBLEM OF PLACING UNDERGROUND ENGINEERING NETWORKS IN LARGE CITIES, ECONOMIC APPROACHES AND PROSPECTS.

***Usmonov Quvat Turdiyevich** ,*
c.t.s.. associate prof
*assistant **Orazbayeva Nazokat Maksetovna**.*
Email: nazokat@6563gmail.com
Tashkent University of Architecture and Civil Engineering.

Annotatsiya: Shahar hududlarida YoMTning zichlashuvi, eskirishi va ta'mirlash qiyinligi kabi muammolar ko'rib chiqiladi. YoMTni joylashtirishda qo'llaniladigan ilg'or texnologiyalar, jumladan, GIS, 3D modellashtirish va sensorli monitoring tizimlari o'rganiladi
Kalit so'zlar: yer osti muhandislik tarmoqlari, shaharsozlik, GIS, 3D modellashtirish, aqlli tarmoqlar, barqaror infratuzilma, yer osti kommunikatsiyalari, urbanizatsiya, innovatsion yechimlar.
Annotatsiya: Рассматриваются такие проблемы, как плотность, устаревание и внимательность обслуживания общественного транспорта в городских районах.
Изучаются системы ГИС, 3D-моделирования и сенсорного мониторинга.
Ключевые слова: подземные инженерные сети, городское планирование, ГИС, 3Dмоделирование, интеллектуальная сеть, устойчивая инфраструктура, подземные коммуникации, урбанизация, инновационные решения.
Abstract: Issues such as conGEStion, aging, and maintenance of public transport in urban areas are addressed. Advanced technologies used in the deployment of public transport, including transponderless technologies
Keywords: underground engineering networks, urban planning, networkless technologies, GIS, 3D modeling, smart grids, underground communications, urbanization, innovative solutions.

Introduction: The steady growth of the population in cities and the acceleration of the urbanization process are placing increasing economic and social demands on urban infrastructure, namely underground engineering networks (UEN). UEN is an element of important civil engineering sectors that ensure the vital activity of cities and includes the following services: electricity, hot and cold water, gas, communications and sewage. In developed cities, underground engineering networks (UEN) are an important component of modern society, providing daily vital services to city residents. Ensuring the uninterrupted operation of UEN is important for the sustainable development of cities.

Underground engineering networks are mainly located under the city's street and road networks. The procedures for their placement are based on regulatory documents governing the field of urban development. These regulatory documents establish the following procedure for the placement of underground engineering networks in the cross section of a city street: high and low voltage cables are placed between the construction line and the red line (communication, signal, telephone, and dispatcher, etc.); underground engineering networks such as hot and cold water and gas are placed between the red line of the street and the carriageway; a pipeline for draining wastewater generated from the area is placed under the carriageway of the street[1].

However, existing public transport systems in developed cities face a number of problems.

❖ The dense location and aging of the networks, i.e., much of the TSO infrastructure was built several decades ago and is now in need of renovation and is aging.

❖ The difficulty of repair and maintenance, as TSOs are often located in densely populated and heavily trafficked urban areas, making it difficult to carry out repairs.

❖ The negative impact on the environment can lead to excavations in the area, soil erosion, and groundwater pollution;

❖ The complexity of management and monitoring, which reduces efficiency due to the lack of coordination between engineering networks managed by different organizations.

From an economic point of view, the costs of constructing and maintaining underground engineering systems can be more expensive than above-ground systems.

1. Considering the separate placement of engineering networks, we can see the impact on road infrastructure. The following processes are carried out for the placement of engineering networks:

Excavation works open the road layers for the installation of underground communications. Laying pipes and cables - water, gas, electricity - communication and sewage networks are laid.

Road surface restoration - excavated areas are re-asphalted or covered with concrete. Such processes lead to rapid wear of city roads and increase operating costs.

2. From an economic point of view, excavation and repair of road layers is one of the significant sources of costs when laying underground engineering networks. On average, excavation and laying of pipes - 150,000 - 500,000 USD per 1 km is required.

- Asphalt
- Fine-grained concrete: 10-12 cm
- Waterproofing
- Crushed stone fraction 5-40 mm: 15-20 cm
- Sand (sand): 15-20 cm
- Soil (soil

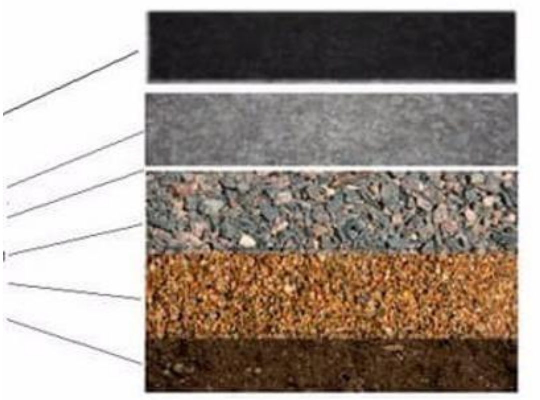

Figure 1. Cross-section of the road surface layers.

Consists of soil, sand, gravel and asphalt layers from bottom to top. The asphalt layer is laid with a slope (0.8-1.5%) and the thickness of each layer is given in centimeters.

Comparing underground and above-ground engineering networks, we can see the costs for repairing 1 m^2 of asphalt road in the table below.

Table 1

Types of costs	**Work performed**	**Expense account S. (US dollars)**
Excavation work	Removal of earthworks	100-110
Removal of old asphalt	Leveling of the base layer	50-120
Soil compaction	Use of mechanisms	60-120
Gravel laying	Gravel sand mixture	80-150
Gravel sand mixture	Asphalt subgrade preparation layer	100-120
Coarse-grained asphalt laying	Leveling of coarse-grained asphalt	150-180
Laying fine-grained asphalt	5-10 cm thick asphalt	200-300
Strengthening the edges of the road	Curbs and other elements	50-150
Installation and drawing of signs	Drawing of road lines	35-80
Total costs (1m2)	**On average**	**800-1300**

It can be seen that the cost of repairing 1 m^2 of asphalt road can be approximately 800-1300 US dollars, and for a complete repair of 1 km of asphalt road - **100,000-1,000,000** US dollars. In addition, the dynamics of prices may vary depending on the specifics of each area and the project.

Given the high cost of each hectare of urban area, it is necessary to narrow the width of the streets. It is advisable to place underground engineering networks and communications under the streets not in a single or common trench, but in common collectors. Placing collectors only under the sidewalk is a progressive method in urban engineering improvement[1].

Although underground engineering networks initially require large costs, it is recommended to place them in a system of collectors that will allow for efficient use of the territory and environmental sustainability in the long term. Reducing costs through modern technologies.

The cost of excavation and repair can be reduced by introducing modern technologies:

Microtunneling technology - cheaper than traditional excavation and less damaging to the infrastructure of road elements.

Horizontal drilling method - allows for the installation of pipes without excavation, which does not damage the road surface.

Sensor systems and monitoring - by constantly monitoring the operation of engineering networks, accidents can be prevented and repair costs can be reduced. Although the placement of engineering networks underground requires a large initial investment, it increases the efficiency of urban infrastructure in the long term. It is advisable to use modern technologies to reduce damage to road infrastructure and optimize operating costs[4].

The most economically advantageous method of laying underground communications is the combined complex laying of underground utilities in common collectors, as the most advanced recommendation in terms of indicators.

When laying underground engineering communications underground, their laying using protective layers increases the resistance of engineering communications to external (dynamic natural and man-made) influences and contributes to the reliable operation of the system.

To solve these problems, it is necessary to search for and implement modern urban planning and engineering solutions for the placement of UMT. To analyze existing problems in this area and consider modern solutions, as well as to identify promising areas for the development of UMT in our cities in the future.

Conclusions and recommendations: The depth of laying of engineering networks (from 0.7 meters) is determined taking into account the technological features of their construction and exploitation, natural factors; relief, geological, hydrogeological, climatic and other conditions[2].

The minimum depth of laying networks from planning features is determined in order to prevent their accidental damage under the influence of static and dynamic

(transport) loads, taking into account the depth of soil freezing in a given area (0.50.7 m.)[3]

Laying of public transport in cities is a complex and multifaceted task, requiring innovative solutions and integrated approaches. GIS, 3D modeling, sensor monitoring systems and "smart" networks allow making public transport more efficient, reliable and sustainable. In the future, the wider application of these technologies in the field of public transport and the development of new solutions will greatly contribute to the modern sustainable development of cities.

- Taking into account territorial planning documents in the planning of public transport
- Widespread use of GIS technologies in public transport management
- Promoting the use of technologies in repair and reconstruction work
- Introducing sensor systems to monitor the condition of public transport
- Supporting the use of sustainable materials and technologies
- Encouraging scientific research and introducing innovations in the field It is necessary to review successful projects for the deployment of underground utilities in various cities.

The above conclusions and recommendations can be used as a broad application and recommendation in the field of urban planning, planning and development of underground engineering networks in our cities.

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