

detection and classification of structural defects, streamlining the analysis process and improving accuracy.



Fig. 1. Aerial photography involves taking images of structures using using unmanned aerial vehicles



Fig. 2. Drones are Revolutionizing High-Rise Construction

**Application.** The use of remote sensing to monitor the condition of structures and assess damage is widespread in various sectors:

1. Civil infrastructure. Bridges, highways, dams and tunnels benefit from regular remote monitoring to identify potential vulnerabilities and prioritize maintenance work.
2. Oil and gas industry. Pipelines, offshore platforms, and storage tanks require constant monitoring to reduce the risk of leaks, corrosion, or structural failures.
3. Urban planning. Remote sensing data helps urban planners assess the condition of buildings and infrastructure, provide information for renovation projects and disaster preparedness initiatives.

**Challenges and future directions.** Despite its many benefits, monitoring the condition of structures using remote sensing still faces a number of challenges, such as the difficulty of interpreting the data, sensor limitations, and cost considerations. Future research should focus on improving sensor capabilities, developing standardized protocols for data analysis, and developing interdisciplinary collaboration to effectively address these challenges.

**Conclusion.** With the rapid development of society and the economy, significant infrastructure, such as roads, buildings, high-speed railways, and bridges, have been built all over the world. However, the increase in operating time and environmental loads have destabilized the structures, resulting in slow structural damage. Such damage, if not detected in time, can threaten normal structural operations, or even cause significant hazards. Therefore, the operational safety of urban infrastructures, as an important practical issue, has attracted increasing attention from multi-disciplinary fields, such as public security, earth observation, civil engineering, and so on. However, since the urban infrastructure is widely distributed, the current manual periodic detection and on-site automatic sensor monitoring methods are spatially or temporally incomplete, and damage could remain undetected. Thus, there is an urgent need for developments in the field of remote sensing technologies that offer promising solutions to overcome these problems.

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## DEVELOPMENT OF THE SCENARIO FOR THE TRANSPORT INFRASTRUCTURE IMPROVEMENT OF HAHARIN PLATEAU

**Popova O.**, *student of group TR-430*

*Scientific advisers – Lapina O., PhD., Associate Professor (Department of Transport Roads  
and Airfields),*

**Maryanko Y.**, *PhD., Associate Professor, (Department of Foreign Languages)  
Odessa State Academy of Civil Engineering and Architecture*

**Abstract.** The formation peculiarities of the transport infrastructure of the Arkadeya area and the modern problems of its functioning are analyzed. The probable scenarios of infrastructure development are presented, the advantages and disadvantages are determined. The version of the scenario for the transport infrastructure development of the district, which will meet the needs of the population and create a favorable environment for the population, is proposed. The development of the cities is not possible without the proactive creation of the transport infrastructure with comfortable, high-speed and safe junction. The work is devoted to the description, study and evaluation of the transport infrastructure within the urban space with the aim to create a comprehensive development program of the territory aimed at meeting the needs of local citizens and tourists and creating a favorable environment, therefore it is **relevant**.

The new approach to improving transport infrastructure is based on the principle that the streets and roads are both public places and transport arteries. The street design should take into account the needs of pedestrians, drivers, cyclists, as well as the users of public transport – and all this within a limited space. Many city streets appeared in different historical periods and must change considering modern requirements. The historical conditions actively influence the development of transport infrastructure.

The planning and territorial development of Odesa city can be conventionally divided into five stages: from the rectangular development of the center according to De Volan's project (1974), the development of the suburbs (1820-1860), the planless development (1860-1917), the restored pre-war and compact and uniform building planning during the post-war periods.

The modern urban scenario provided according to the city's general development plan was adopted in 2015 [1]. Even now, the issue of improving the planning characteristics and development of the existing road network in accordance with the intensity of traffic and pedestrian traffic, the possible isolation of the traffic routes from the pedestrian traffic, and the elimination of intersections of significant traffic streams at the same level remains relevant [2].

The traffic capacity of the streets has already been exhausted. The historically built rectangular development cannot be expanded or duplicated in connection with the compact conditions of the development of the historical part of the district. The catastrophic transport situation has developed in one of the well-known resort areas of Odesa – Arcadia. The development of transport infrastructure in this area is closely related to the history of its development.

The Belgian Emil Cambio, the head of the Odesa agency of the Belgian horse rail-roads, is considered to be the pioneer of Arcadia [3, 4]. The mentions are found in 1893 in Odesa newspapers. At the same time the very name “Arkadia” appeared. As known, it was the name of the area in Greece, which, thanks to the poets, came to be perceived as a fertile area, a little corner of paradise.

Arcadia quickly became popular (Fig. 1). An interesting contrast is both the elite French Boulevard, where the dachas of the Odesa nobility (Marazli, Mavrokordato, Papudova) were located, and the Novo-Arkadiyskaya road (now Shevchenko Avenue) led to Arcadia, those days there were slums the poor lived and crime flourished.



After the revolution of 1917, the dachas of Odesa business barons became to sanatoriums, but the dachas and houses of Party workers appeared around Arcadia. The hotels were built. In the 1960s the shore fortification works were carried out, the beach was significantly expanded.

After the difficult period of the 1990s, Arcadia again experienced the boom period and active construction – new summer playgrounds and fashionable nightclubs appeared, where the guests from other cities and countries come to relax. In this place they want not only to relax, but also to live. In May 2008, the construction of Haharin Plateau was “started”. With the help of the Planet Earth program from the Google Corporation it is possible to watch the changes in Arcadia since 2004 using the images from the space (Fig. 1) [5]. Many high-rise residential complexes have appeared and continue to be built.



Fig. 1. Development of Haharin Plateau in the period 2004-2018

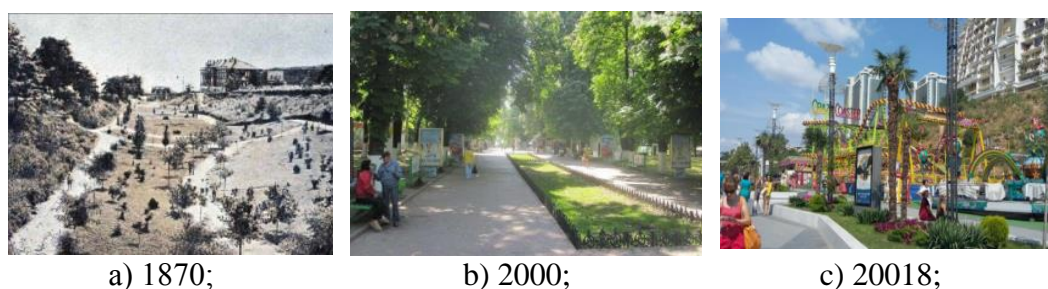


Fig. 2. Arcadiysky balka and the central alley

The opinions about the current appearance of Arcadia and Haharin Plateau are different (Fig. 2), but both the supporters and the opponents are not satisfied with the state of the transport infrastructure.

The Arcadia area is a residential and resort area of Odesa city, located in the Primorsky district of the city, at the Black Sea shore, not far from the 5th-7th stations of the Bolshoy Fountain on the Gagarin Plateau. The population density in this area is more than 12,000 people/m<sup>2</sup> of permanent residents. The quantity of tourists in the winter period is about 1,000 people/day and up to 7,000 people/day in the summer period.

You can get to Haharin Plateau and Arcadia from the side of Shevchenko Avenue and Posmitny Str. with the road out to Henuezka Str. Henuezka Street (length 1240 m) is a dead end and ends with the roundabout 307 m long. The width of the traffic area on Henuezka Str. is 7 m. The transport stream is mixed, consisting of the cars, buses, taxis, trolleybuses and trams. The traffic intensity on Henuezka Str. is from 2,500 vehicles/day. The traffic jams are constantly on this section of the road network.

In recent years, the city has carried out the repair and reconstruction works, however, they gave only a temporary positive effect. The growing pace of construction and development of the resort business increases the transport network load and complicates the entry and the exit to the Haharin Plateau. The width of the street does not allow solving this issue by widening the roadway, because the distribution resource is exhausted. Therefore, it is necessary to develop non-standard scenarios for the development of the city and its districts in the projects to improve the transport infrastructure [6].

The participation in summer schools and academic mobility seminars [7] allowed the author to formulate the strategic directions of the transport infrastructure development scenario and classify them. The considered scenarios are listed in Table 1.

Table 1 – The main scenarios for improving the transport infrastructure  
Scenarios Summary

Rough plan

Scenario: underground transport.

The construction of tunnels and semi-tunnels of various geometries for urban transport.



Scenario: multi-level traffic road.

The above-ground part, as a part of the space for pedestrians and sports (bicycle track).



Scenario: construction of a multi-story parking area.



Scenario: a semi-tunnel with purpose-built pedestrian bridges that connect transportation, shopping centers, residential areas, and other facilities.



Scenario: an elevated road.

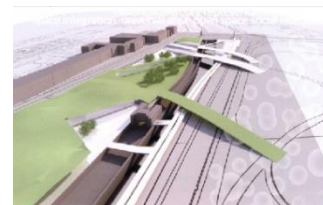
The construction of a highway in the upper level for multidirectional traffic at different levels.



Scenario: to reduce car traffic, to introduce “Park and Ride” parking system at the beginning of the street, which will become a transfer point, where car traffic will be replaced by public transport and bicycle traffic. “Put the tram under the ground”.



Script: Eco-human. It takes into account historical, ecological and aesthetic issues. It provides for the creation of transport infrastructure at different levels, considering the originality of the district.



After analyzing the proposed scenarios: geological conditions, the purposiveness of the district, it is possible to recommend the scenario for the development of eco-human transport infrastructure. Given the fact that the Arcadia district is not only a tourist and resort area, but, first of all, a favorite vacation spot of Odesa residents, and a residential area, and the residents of Odesa need to feel comfortable there, like at home. Therefore, one of the main directions in the improvement of transport infrastructure is the solving of social conflicts and the creation of an environment that will be comfortable for both residents and tourists. Such a scenario will take into account the physical needs of the district and cultural values.

The decision to improve the transport infrastructure of the Arcadia district according to the Eco-human scenario involves the following measures:

- to create a network of one-way tunnels and semi-tunnels in the central part of the street and on the roads to the roundabout;
- the roadway construction of continuous traffic;
- the expansion of traffic area of the existing road;
- the construction of underground and above-ground pedestrian subways;

- the construction of crossroads at different levels;
- the development of temporary and permanent parking spaces;
- the preservation of the modern architectural complex;
- the preservation of existing and planting of new green areas.

Considering the historically developed planning structure of the central zone of Henuezka Str. and the existing traffic organization in the project defined sections of highways on which it is possible to introduce one-way traffic. This will make it possible to increase the traffic capacity of the roadway without taking the measures to expand the roadway significantly. It is also possible to use one or more lines for temporary parking.

In order to be relevant, the roadway of Henuezka Str. must be developed simultaneously with the Arcadia area and Haharinsky Plateau. It is necessary to develop and “go outside”, interact with the district. To materialize this statement, it is proposed to create a complex multi-level transport structure through the rotation with “exit to the outside” (Fig. 3).

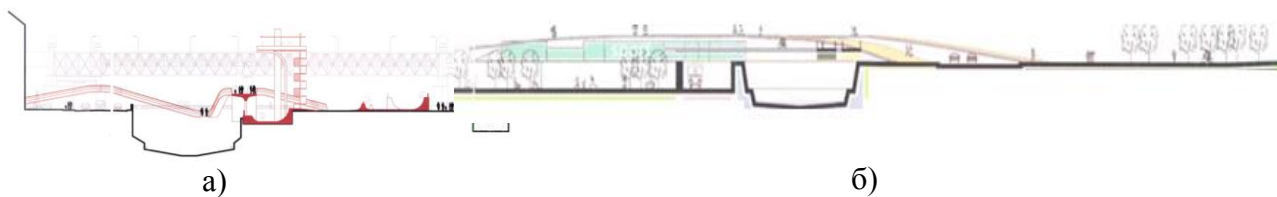


Fig. 3. Cross-sections of Henuezka Street according to the eco-human scenario:  
a) near the building 36; b) near the building 24

Improving the transport infrastructure according to the eco-human scenario will not only solve the transport issues, but will also create a comfortable environment for the tourists, improve the quality of life of local residents and be a harmonious addition to the formed architectural ensemble of the renewed Arcadia.

#### **Conclusions:**

1. The research work analyzes the historical features of the transport infrastructure formation of the Arcadia area in Odesa city and the modern problems of its functioning.
2. Based on the experience gained during the academic mobility there are probable scenarios for transport infrastructure development. Their advantages and disadvantages are determined.
3. The variant of the transport infrastructure development scenario of the Arcadia area in Odesa is proposed, which will provide for the needs of the population and create a favorable environment.
4. The principles laid down in the above transport infrastructure development scenarios can be used for other projects, based on certain conditions of the object that needs improvement.

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