

ARCHITECTURAL AND PLANNING DEVELOPMENT OF THE TRANSPORT STRUCTURE IN BAKU AGGLOMERATION SYSTEM

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Abstract. The architectural and planning analysis of the developed transport infrastructure of Baku city is studies in the paper. The characteristic directions and main drag branches, accesses and roads with reference to step-by-step development of the city are given. The historical, geographical and economic premises of formation of architectural and ecological environment of the city is analyzed. On the basis of analysis of the development history of the transport infrastructure of Absheron peninsula since 1986, the trends of transport system development in the planning structure of the capital region is investigated. Directions of alternative eco-friendly transport modes development (tramway, electrobus) as a foundation for transport problems solutions in Baku agglomeration are presented.

Keywords: *transport, ecology, urbanism, architectural analysis.*

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1. Introduction

The reason for the emergence of the city on the Absheron peninsula was the physical, geographical and climatic conditions. Location of the city in the center of the intersection of migration and trade routes stretching from north to south and from west to east (Silk Road), as well as fuel and energy wealth made the city of Baku unique.

During the whole century, while the architectural and planning structure of Baku was formed, its development in this direction was not always uniform.

Medieval Baku was built inside the fortress walls. Of course, Baku could not always remain like this. Forstadt appeared, then the planning schemes of then outstanding civil engineers such as N.A. von der Nonne. His first scheme was made before the 1917 revolution.

The first scientifically developed master plan appeared in 1925-1927. Its author was Professor Semenov-Prozorovsky. The following master plan was developed in the mid-1930s by Professor L.A. Ilyin with the participation of A.Ivanitsky – in fact, the image of modern Baku was laid by them. This plan developed up to 1965 and left its noticeable mark during the Soviet period.

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The most prominent masters of Soviet architecture worked in the city: A.V. Shchusev, the Vesnen brothers, G.B. Barkhin, I.V. Zholtovsky. Local, Azerbaijani architects were not inferior to them: M. Useynov, S. Dadashev and G. Majidov.

Subsequently, in 1974, under H.Aliyev, a new master plan for the development of the city of Baku was developed with a calculation until 2005.

Effective transport accessibility provisions between cities and objects of infrastructure objects of the interurban transport and inland transport is one of the fundamental tasks the modern urbanists face. (Arıcı, 2014). The geographic location of the city, its proximity to the sea, mixed relief – all these affected the formation of the planning structure of Baku at the same time as building and organization of the transport junctions, roads and architectural space solution.

Throughout the development of the architectural and planning structure of the city of Baku, such scientists as F.M. Huseynov, N.G. Nagiyev, A.A. Hasanov, etc. In his scientific writings they conducted research on the development of transport infrastructure of the Absheron Peninsula. Experts in urban planning and sectors associated with it faced serious transportation problems occurred in the period of economic and political crisis caused by transition to the new formation into post-soviet period, which resulted in disruption of development of the former USSR regions. General lay-outs of the cities and resettlement systems of constituent republics had to be reconsidered and brought in sync with the market economy conditions.

Starting with independence acquisition in Azerbaijan special attention is given to transport infrastructure development. Supported by the President of Azerbaijan Aliyev I.H. initiatives to modernize the transport system in the republic and capital region are being implemented. Despite of the difficulties of the transition period tangible results were achieved in the sphere of transport system development in a relatively short period of time.

The purpose of the study: Alongside with the current measure on optimization of transport infrastructure functioning in Baku agglomeration, development of a network of environmentally sound of transport types (underground railway, city tramway, above-ground light railway, cycling roads ad etc.) will also let relieve street and road network, improve the ecology of the city by means of constriction exhaust fumes, reduce time and money spent on trips (Narbekov, 2016). With this aim reduction of trips by private car without passengers, development of urban transport, cyclist and pedestrian traffic infrastructure, construction of multimodal connection hubs of higher transport accessibility for all categories of citizens including the people with limited physical capacities is one of the major tasks of transport system development in Baku agglomeration.

Breakup of the USSR, following on it the sweeping political, economic and social reforms in Azerbaijan rebound for urban development rate, urban and rustic resettlement pattern. The city-planning policy eligible for USSR under conditions of new market economy became ineffective, and demands new ways and methods of territorial planning. In this light the perspective development of capital city Baku is one of the most serious problems of city-planning of Azerbaijan.

In modern times, Baku is the only megapolis in the country and the hub of Baku agglomeration. More than half of the population of the country, majority of sociocultural and educational establishments, industrial complexes of Azerbaijan are concentrated here. More than %70 of the industrial potential of the country is located in Absheron economic region. Such an unique position of the city and Absheron peninsula is

historically formed. From the XIX century onwards, the development of the petroleum industry determines the explosive growth of the city and intensive migration of population here from all regions.

Taking into account the above and proceeding from modern ecological requirements of development of Baku agglomeration, these researches are relevant today and require wide, multilateral development of transport infrastructure of Baku city.

Today under conditions of the current favorable investment climate Baku experiences its new birth as the largest economic and cultural center of Transcaucasia. Some of the most ambitious projects of the world (Flame Tower, Heydar Aliyev Cultural Center, Crystal Hall and etc.) are already realized here, and it is planned to create the more large-scale projects. (Plan of Regional development, 2020). But is everything successful in urban planning in Baku? (Fig.1)



Azerbaijan Carpet Museum (2014)

Heydar Aliyev Cultural Center (2012)



Baku Crystal Hall (2012)

Flame Tower (2013)

Fig.1. Some of the most ambitious projects of the world (photos from <https://www.go-world.ru/>)

In present time the most economical rating fall on Baku and Absheron peninsula again. Population of the regions migrates to Baku on a job search. Overpopulation of the country resulted in the fact that high-rise apartment houses and public facilities are constructed everywhere in Baku, almost each sliver of land is reclaimed, forest belts and green spaces are being cut down for housing construction. The city develops also occupying the territories of oil-fields. Large residential areas are constructed over the Badamdar, Zikh, Sulutepe, Sabunchu and the other areas. Unmanaged settlements squeeze Baku into a tight ring almost from all sides. (Plan of Regional development, 2020) (Fig. 2).

The sharp increase in the urban population bears heavily on the infrastructure of the city, which was not designed for so many people. Almost all engineering lines have not been modernized for many years.

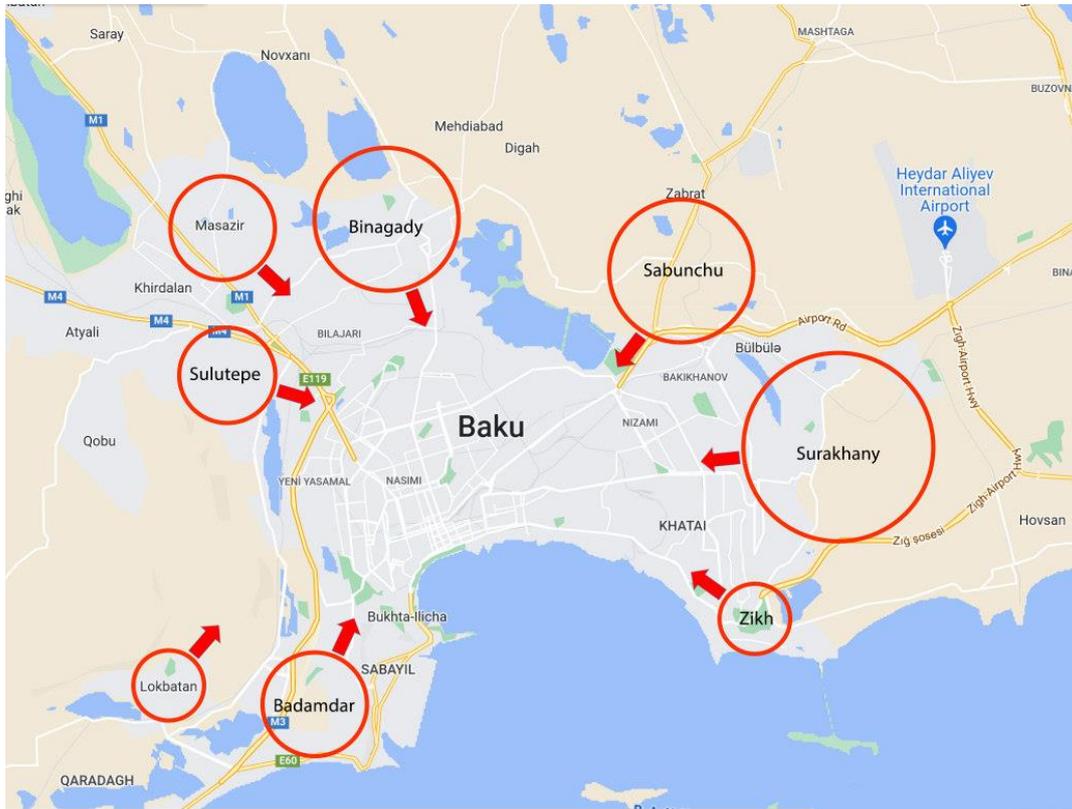


Fig. 2. Unmanaged settlements Baku

2. Architectural and planning analysis of the current transport infrastructure of Baku city

The architectural history of the center of Baku city can be divided into a number of stages each of which is identified through the building system of urban area from one hand, and transportation facilities development from the other hand. At the same time, the importance of the street as an element of public life increases.

The laying of wide, so-called ‘front’ streets (for example, Nikolaevskaya - now Istiglaliyyat Street, seafront - Neftchilar Avenue) was started before the development of automobile transport, already in the 19th century (Pic.3). These streets was just of representative value. The uprise of the horsecar and later the tramway and automobile, put forward new demands, which assumed separation of directions of movement, the planting of protective green belts and the construction of pedestrian ways. On the streets of a commercial nature, the possibility of unimpeded stopping and slow movement of mechanical transport at the sidewalk line had to be taken into account. At this time, the build-up of the streets is characterized by following the ‘red line’ and height capability regulation, although there is no connection between the nature of the facades of houses. (Volkova & Litvyak, 2019).

The peculiar outline of the Baku Bay and amphitheater character of the territory adjacent to it leave a mark on build-up of rapidly developed city.

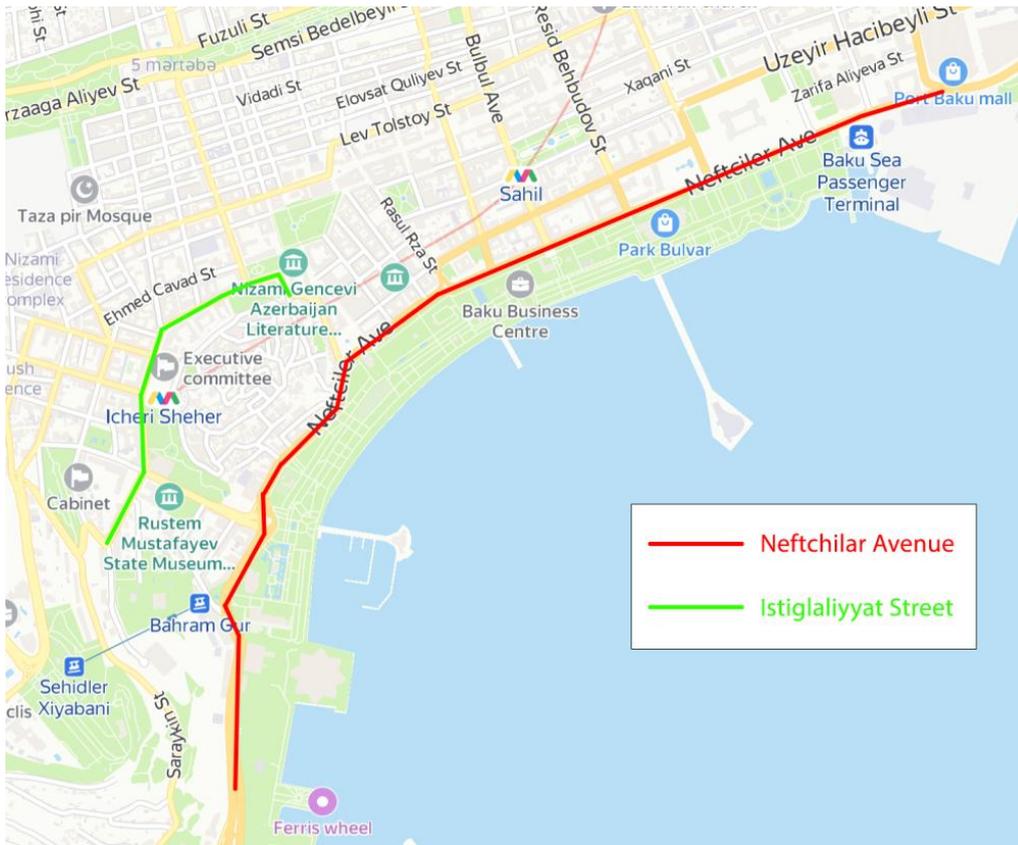


Fig.3. Istiglaliyyat Street, seafront - Neftchilar Avenue

The key factors of formation and development of the highway architecture of Baku are the following (Fig.4):

1. open amphitheater location of the city in regard to seashore and its main historical (the Western) residential area;
2. terraced slopes of the amphitheater bowl, the main role in which plays the terrace edges, enriching the possibilities of the compositional and functional arrangement of highways;
3. industrial character of the city affecting the formation of urban highways and identifying its nature;
4. continuous growth of Baku from the mid-19th century onwards, which created the definite conditions of build-up demanding the specific solutions and forcing out of planning and developing of the highway in several directions at once;
5. Centricity of the whole composition of the plan.

It stands to reason that the system of highways and city center-hubs determines the general planning structure, which depends on functional distribution of the city territory. Alongside with city-wide system and the main center, local region systems with the regional highways and local centers had been formed and have been continuing to develop. The common system of the main highways of Baku city is considerably formed based on radial ring principle, but the history of city build-up left a mark on the components of this system, which is especially evident in the central part of the city.

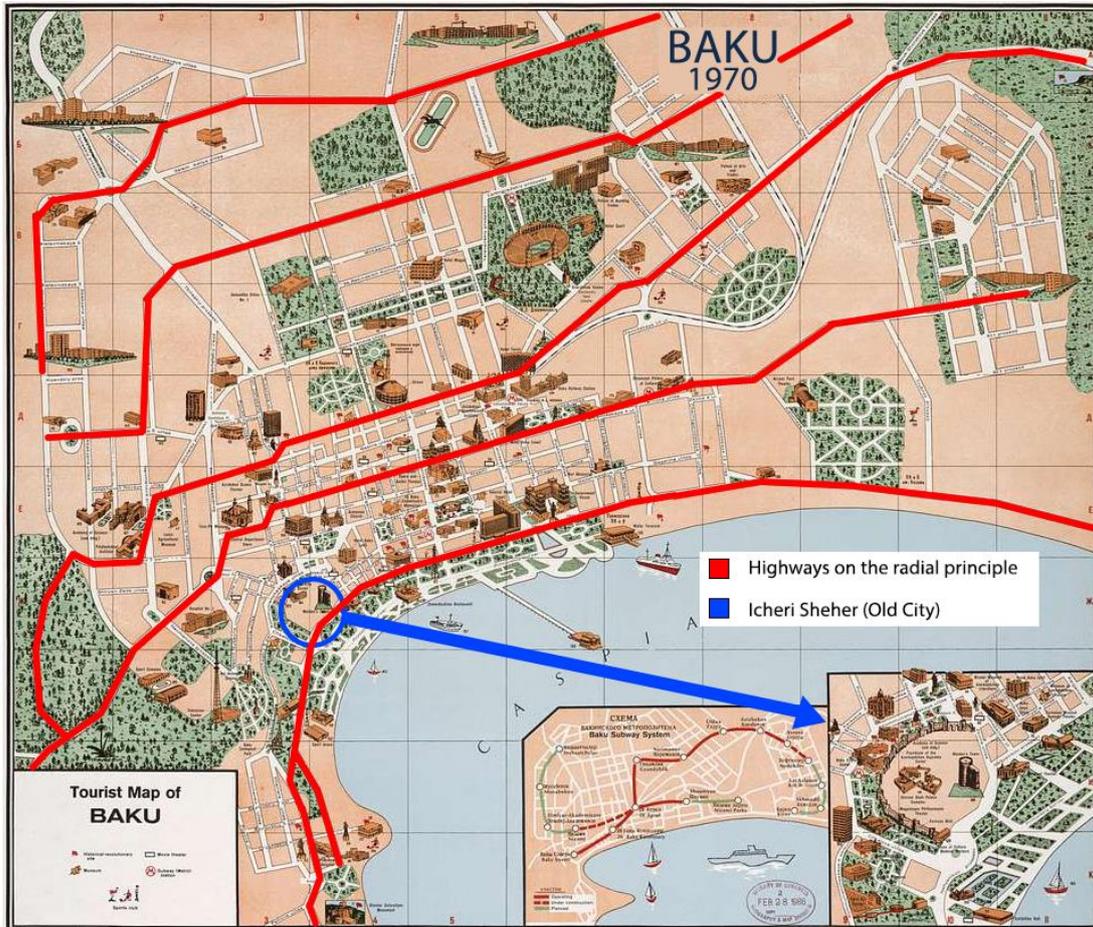


Fig.4. Baku Bay and the amphitheatre character of the adjacent territory
(Map of Baku: Baku, panoramic plan 1970)

The position of the beginning of highways along the external outline of Baku is very strictly justified by topographic and technical and economic conditions (Efendizadeh, 1986). These entrances and lodge-gates to the city from the West to the East are the following (Fig.5):

- the South-West entrance through Shixovo – Khanlar – Bibi-Heybat – Bailov and further to the Neftchler ave.;
- the West entrance – provide the local connection with Yasamal valley through the old ‘Gurd Gapisi’ and mountainous plateau through the Mushvig M. str. to Nizami and Fizuli str.;
- the North-West entrance through the Jeyranbatan – Bilejeri regions to Tbilisi ave. to Jafar Jabbarli str. and Azerbaijan ave.;
- the North entrance – provides the connection of the city with the Northern seashore of Absheron through Binagadi and further to Azadliq ave. till Azadliq square;
- the North-East entrance – provides the connection of the city with central part of Absheron and the main oil-producing trading through Boyuk Shor – Keshle plat and through Haydar Aliyev ave., Safarov Y. str. and Hajibekov U. str. till the center;
- the East entrance – provides the double entrance to the city through central and East Absheron and provide local connections with the region of Bakikhanov – Suraxani

settlement through Ahmadli, goes to the center through Babek ave., Khojali ave. and Aliyeva D. str.;

- the South-East entrance – from the Eastern Absheron and sea tradings through Zikh settlement, Nobel ave. and Hajibeyov U. str.

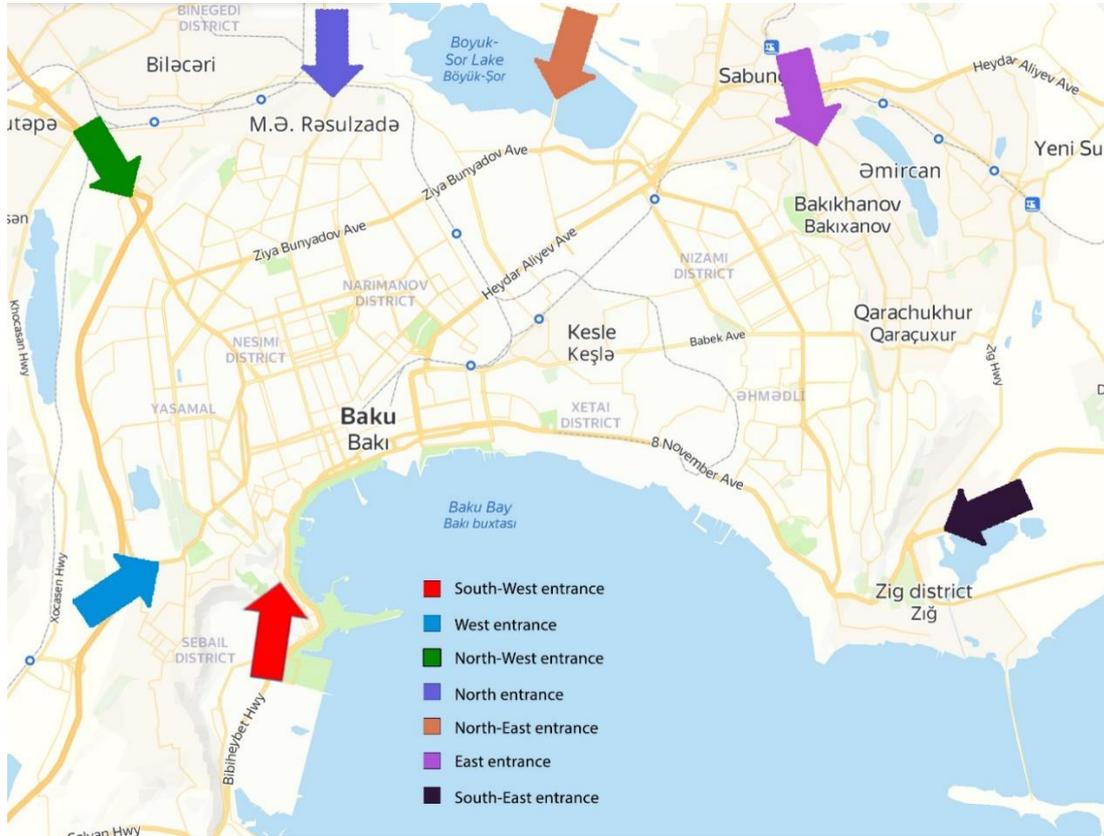


Fig.5. Entrances to the city from the West to the East

The four of all mentioned entrances provide external connections and 3 of them - local absheron connections. The North-West entrance providing access to the main regions of Azerbaijan is of maximum value; the next one is the South-West entrance opening into the central Absheron. Accordingly, in recent years, the significance of the entrances was confirmed by their new architectural and planning solution that meets modern requirements, functions and parameters. All the mentioned entrances were outlined in the further historical past of Baku, consolidated by the subsequent development of the city, and are reflected in the planning works carried out in the 20th century. The detailed analysis shows that their location is fundamentally set up with the planning point of view, and there is no other alternative solutions. This contributes to enhancement and reconstruction in present time in the construction of highways. Based on past master plans, the number of entrances for such a large city as Baku was always insufficient, more so that the locations of exits and entrances, and accordingly, the access to them were unevenly distributed. The large distances between some mentioned above highways brought to radius formation (or radial highways and streets), which do not have indirect external exit or ending in the city itself or in its peripheral parts. This is one radius in the West, two are in the North and one is in the East. All of them have a fairly strong architectural content at the end:

- the Western: towards Aliyeva M. str., prolonging through the central Eastern exit from Khojal ave., ends by the Science Academy building complex;
- the Northern city: goes through Vurgun S. str., doubles Azadlig ave., and ends with the region of the park in Mammadyarov settlement;
- the Northern industrial: goes through Metbuat ave., running into Zardabi, which forms traffic circle at the intersection with Vagif str. and Salamzadeh str.;
- the Eastern: the exit goes to the direction of ‘8th km’ region, and ends with the main center of this Eastern residential area

Among all radiuses the most transportation lane-based significance belongs to the North-West and the North-East radius-exits. The most interesting are the radial directions that are part of the latitudinal diameter, specifically along the route: Academy square – Aliyev M.A. str. – Fuzuli str. – Khojali ave. – Nobel ave. – the center of the Eastern residential area Ahmadli.

The entrances to the city give first impression of the city. In the historical past, they were fortress gates and outposts. In the period of uncontrollable spontaneous development of the capitalist city the entrances in the city were not organized at all, and the entrances passed through a spontaneous mass of supplementary, service buildings and industrial enterprises (Fatullaev, 1986). The planned development of the modern city allows and even bind over forming the well set up entrances to the city. The higher traffic of the transport increases opportunities of architectural and space planning of the highways.

In modern megapolis organization and architectural improvement of the entrance cannot be delimited by one point, but should cover the whole space of road approach, within the bounds from suburban area upstream of spontaneous urban development. (Plan of Regional development [e-resource], 2020). On the way of entry, the organization of a few hubs in the most expressive places providing good visibility from great distances is inevitable.

Radial highways providing connection of the urban territory with the center play a very important role. The radial highways concentrate the main movement of the masses of the urban population, and this obviously stipulates the expediency of public facilities placement on them. Transport needs determine the significant transverse dimensions of radial highways (Erdoganaras, 2019). Taking into account that till 1990s the radial arterial roads on health concerns are often accompanied by boulevards, it means that they represent sufficient and rich material for the analysis of their architectural significance in the urban development.

The seabound ring main were being developed into archs, which provided the connections of remote area of the city, and at the same time were designed for unload of its central part from the cut-through traffic. Of course, the term ‘ring main’ is formally inaccurate as long as there is no fully closed ring in Baku by the impact of its seaside location. Thus, the center of the city found its position at the coast of Baku bay, where ring highways, the main arterial roads of the city, cross over. This center is Azadlig square (Map of Baku, 1970) (Fig.6).

They are of quite considerable sizes for provision of rapid and safety traffic. By attracting the large number of passengers and freight flow, the ring highways become to be the focus of a significant number of public buildings and buildings of a service nature at the same time. These conditions stipulate the solution of their build up as a system of architectural dominants connected to each other. In comparison with the planning of the urban centers, its radial avenues, the architecture of the arch highways possesses specificity, which demands special approach to their artistic formation.

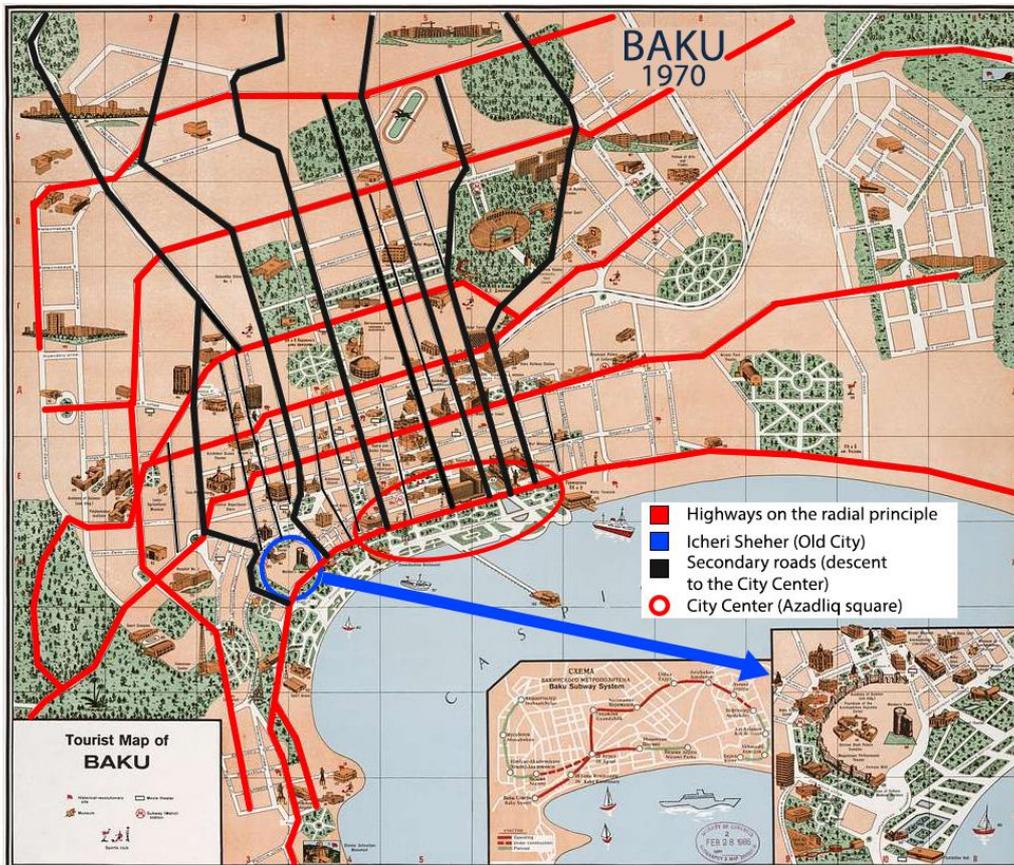


Fig.6. Map of tiers and descent to the City Center (Azadliq square)

We can note their following tridimensional features: significant linear length; different conditions of passage on the relief; historical formation of the urban planning; crossing over a large number of radial avenues, each of which has its individual characteristic feature (Guezey, 2009). At the same time, they are relatively less connected with the existing buildings, since a significant part of their formation takes place in those areas of the city where there is no significant supporting development.

3. The features of architectural and planning solution of the transport hubs of the main highways in Baku city

The features of the architectural and planning solution of the transport hubs of the main highways of the Baku city significantly affects the architectural characteristic of the different parts. It is remarkable that in Baku this general characteristic should be supplemented by an indication that in a number of places they pass along the edges of the plateau, where a wide panorama of the bay and the seaside part of the city opens from. It only makes sense that the formation of the architectural appearance of the arch highways is much more difficult in comparison with the radial ones, and has a form of longer process.

Before the end of the 20th century the following main arch highways were identified in Baku:

- Neftchiler ave. (comes up to almost 6 km) – seaside frontage of the city;

- small inner arch (comes up to almost 6 km): through the Niyazi str. – Istiglaliyat ave. – Azerbaijan ave. – Fuzuli str. – Dilara Aliyeva str. – Zorge str;
- middle arch (comes up to almost 11 km): though Elchin T. str. – Huseyn M. str. – Narimanov ave. – Bakikhanov str. – Bunyadzadeh U. str. – Tabriz ave. – Demirchizadeh A. str. – Safarov Y. str.;
- large arch (comes up to almost 21 km): through Javid H. ave. – academician Aliyev H. str. – Aliyev G. ave. – Garayev G. ave. – Ahmadli boulevard;
- external arch (comes up to almost 28 km): Badamdar – Badamdar highway - Botanic garden – Metbuat ave. – Salanzadeh A. str. – Bunyadov Z. ave. – Garayev G. ave. – Ahmadli massive – Zikh highway.

Let us review their main features. The Neftchiler avenue represents the main facade of the city from the sea. As follows from its content and consequence it is more front and important public highway of the city, which the main buildings are located on. The avenue consists of the head ends of two radiuses, but at the same time it also performs the functions peculiar to the ring arterial roads, linking the eastern part of the city with the western one. Until recent times the boundaries of Neftchiler avenue could be considered the docks of the Paris Commune plant in the West and the territory of the sea station in the East. The Eastern part is the port with its own specific appearance. Today it has a direct link to Zikh highway in the East, and to the National Flag square and to the rock Bail hill, i.e. Bailov region in the West. Besides, in view of holding of ‘Eurovision 2012’ competition in Baku, all the docks of the Paris Commune plant and the other industrial and repair facilities along the seashore were transferred to Garadagh region (industrial); and instead of them the Baku boulevard was elongated and opened a beautiful panorama of the city and the bay from the other side of the Baku Bay. The main transport routes through the Bailov were also hacked. There were formed new entrances and exits from Baku in the West.

The inner arch (small) continues mainly through the water front. It consists of magistral character of streets: Niyazi – Istiglaliyat – Azerbaijan ave. – Fuzuli – Aliyeva D. – Zorge. Broadly covering all the center of the city, this ‘arch’ continues mainly through the inner edge of the seacoast side at the beginning of its rise to the middle road of Baku plateau, resting on Neftchiler ave. by its edges. The location and road of this arch can be considered quite determined. Some differences may appear only in the West part: conduct this ‘arch’, as mentioned above, covering Icheri Sheher, or cross the Aliyeva A. – Rasulzadeh M.E. streets. The coverage of the fortress forces you to climb a little on the slope of the middle terrace in the region of Chemberikend, but according to the general character of the covered territory, this decision is much more correct. The ‘arch’ crosses already built up parts of the city, and on a large part of it, the appearance of the built up had already developed.

The deep location of the ‘arch’ in the body of the city, near the very center resulted in a situation where the most of its parts coincide with the direction of highways of the entrance regions of the radial arteries. As it had been already mentioned, the radial arteries of Baku do not cross in one center as for example in Moscow and other European cities of the classic radial ring highways system, but pass through the center of the city as a group of parallel lines (Dinçer, 2020). Such kind of situation complicates the task of space planning of a highway outfit as a whole.

The middle ark crosses the Elchin T str. – Teymurov E. str. (new blanking) – Narimanov ave. – Bakikhanov – Bunyadzadeh U. – Firdovsi Mammadov – Tabriz ave. – Demirchizadeh A. – Plant 10 – Safarov Y. The most part of this arch continues through

the edge of the terrace of Baku plateau, above the hilly part of the once eroded shorefaces. Only in its Eastern part of the highway, it slightly extend away from the geo-topographic basis, goes off the seaside terrace and opens seaward. The arch covers all the central part of the city and forms the shortest connection between all peripheral parts of the Western residential area of Baku. In the East, if we draw a ring in proper form standing by the edge of the middle terrace, it will go to the industrial region, not carrying out its objective. At the proposed highway, the arch has access to the West and the East to the seaside highway – Neftchiler ave. and its continuation to Zikh highway and Bailov. Along the whole length the arch has independent highway. The separate parts of the ring – Narimanov ave., Bakikhanov str. and Safarov Y. str. and the other parts – the Westend and beyond- railway station region – are used just for traffic road as a part of architectural decision. The location of a number of parts of the arch on the very edge of the terrace is considered an interesting feature from the very beginning of the build-up, by means of it most places were always perspective are remains to be the same.

The large arch crosses the highway – Huseyn Javid ave. – academician Hasan Aliyev – Khoysky ave. – Neymatulla A. – Haydar Aliyev ave. – Garayev G. ave. – Ahmadli boulevard. The ring crosses the center of the peripheral parts of the city, actually by the main regional centres. As compared to the reviewed first three ‘arches’, the large arch covers not the only Western residential area, but the whole city with its three part division. It identified its large length – up to 21 km. In the Northern part of the arch in the territory of the Narimanov region there is a specific ‘edge’ at the intersection of Khoysky and Neymatulla A. avenues. This means the necessary walk-over of the area in Narimanov region. In the West and in the East the arch is supported by the radial highways of the external exits of the city, i.e. Aliyev M., and in the direction to ‘The 8th kilometer’ residential area. The external arch crosses the external perimeter of the following city territory from the West and the North. In the East it is located in the safe zone between the industrial and the Eastern residential area.

As well as over the whole city, a part of the panning structure of the city center consists of highway and main hubs planning. In the center we can mark the following main highways:

- latitudinal: horizontal highways – Neftchiler ave., the network system of the streets 28 May – Nizami – Fountain square – Istiglaliyat - Fuzuli;
- meridional: cross cut highways – Azadlig ave. and the parallel streets connected to it such as Pushkin and Amirov F.; Bul-Bul str. – Vurgun S.; Azerbaijan ave. – Razulzadeh M.E. – Aliyev A.

The main hubs, formed by a confluence of highways of various types and functioning, received quite strong architectural content and development due to the spaces widely opened in front of them (Aliyeva, 1988). Such hub-centers in the seaside part of the city, besides the already mentioned main center – Azadlig ave., is the complex of squares of Vurgun S. park. If the Azadlig square is the respectable, more parade and monumental center of the city, the railway hub is the vital center of the city both for its location and for traffic. This was the entrance to the city via electric railway. Figuratively speaking, this is the lobby of the city. This hub develops in the form of a system of squares. Such kind of settlement simplified the solution of transport problem, but complicated the projection of the assembly as a whole. Location of the deeply situated railroad stations and disalignment of the highways converged in this center specifically complicates the architectural treatment. The next linking hub is a group of parks in the Western part of Baku – Nizami, Sabir, and Fountain square. This complex is formed by

means of enhancement of the small old park and destroy of the single-store build-up of the neighbor quarters. The parts of the complex are identified by a number of cultural and educational establishments located in it: Nizami museum, Vurgun S. library, Central Department Store building, Academy of Sciences Presidium building. The main role belongs also to park and garden content of this group. Among the important hubs the Fuzuli square with the Azerbaijan Drama theatre can be marked.

The main citywide hubs are supplemented by the hubs of regional significance (Fig.7):

- Museum complex square;
- Nasimi square and park along the Vurgun S. str.;
- Azadlig park;
- Azneft square;
- Samed Vurgun park complex.



Samed Vurgun park complex



Museum complex square



Nasimi square



Azneft square



Fig.7. Squares and Parks of the Center of Baku (photos from <https://ilham-ahadli.livejournal.com/>)

However, the organization planning structure of such a large city as Baku, wouldn't have been able to do with just one social center. Over the years of development and enhancement of the city territories, the urban planning practice set the substantiation of appearance and creation of the centers with the 1,01,5 km pickup radius of their service. The functionally equitable distribution of the limits of the city led to assignment of the main regional first order centers in the center mall of the terrace of Baku plateau in five places:

- the center of the Mountainous plateau with the complex of Academy of Sciences buildings;
- the North center with the park complex along the Azadlig ave.;
- Narimanov region center along the Neymatulla A. str.;
- the center of the Eastern residential area;
- Ahmadli center.

Besides these first order centers, the natural ruggedness of relief, historically formed ways of urban development, and the very location of the most important objects led to formation of the second order centers located in the same line between the centers mentioned before:

- Bailov center – Sabail region center;
- Shamakhi center – beginning of the Tbilisi ave.;
- The center at the Republic stadium named after Tofiq Bakhramov;
- the Northern-Ahmadli center – the center of ‘the 8th kilometer’ residential area.

It is also worth to note the centers of the regions located on the foreslope of Baku plateau. These centers do well its territory and are the organizational hub of its street network. At the same time they are located in continuation of the main radial highways. First of all, they are the centers of Bakikhanov and Garachukhur settlements, as well as Bilajari and Rasulzadeh settlement. In the seaside part of the city there is one more center developed in the period of explosive growth of socialist construction, and received a new boost in 1950s – the center of industrial region in White city. It was necessary because of the long mileage of the industrial region – up to ‘the 8th kilometer’. Each of these centers was a self-dependent assembly having its own content. The common characteristic feature of them was compositional commitment to the main planning emphasis – the sea. The developed planning structure predetermined the dynamicity of the complete urban composition (Strelnikov & Semenova, 2010).

4. Analysis, development and solution of the transport problem in Baku agglomeration

Baku agglomeration is a compact location, a group of residential locations of Absheron peninsula and surrounding territories joined into a whole by intensive manufacturing, labour, cultural and social and recreational relationships. The population of the agglomeration hub, including the suburbs of the capital and settlements of Absheron, composes approximately 2.2 mln. people (the data of Azerbaijan Republic State Statistics Committee), (Demographic indicators of Azerbaijan: statistical yearbook, 2016) Baku city is the largest city and administrative center of the republic. The industrial concomitant of the capital - Sumgait city is located 30 km away from Baku. The population of the city including the suburb is more than 300 thousand people. The transport accessibility to Baku city composes approximately an hour by car and 40 minutes by commuter train. The passenger traffic flow of railway communication Baku-

Sumgait composes up to 2 thousand passengers a day. To the North-West of the center hub the third most populated city of the agglomeration is Khirdalan (approximately 100 thousand people), located in the distance of 30 minutes from Baku by automobile transport, and 20 minutes by commuter train.

The problem of traffic at the roads of Baku agglomeration is the high tempo of automobilization in the region – for the last 15 years period (2000-2015) the number of private cars in Baku increased 5.2 times (% 104 growth for the period of 2000-2005 years, % 107 growth for the period of 2005-2020 years and % 24 for the period of 2010-2020 years).

The reasons of problems related to the non-compliance of development of the traffic network in relation to the automobilization level are the following: 1) heritage of soviet urban planning – planning of the urban territories, residential areas and development of the transport infrastructure under conditions of planning economics and current system of settlement; 2) change of the social and economic formation, transition to the market economy; credit provision of the private property for movable and real property.

Starting with development of the general plan of the Greater Baku (relatively – 2011) the urban planning in the capital region moved to a new level of development; spontaneous urban planning processes which took place in the post-soviet period are replaced by revitalization of the build-up territory.

The decision to start development of this strategy was taken in 2008. The urban planning and construction code came into force in the Republic of Azerbaijan on January 1, 2013. This code serves to make an end of expansion of the unorganized settlements, which according to experts' assessment, covers more than 15 thousand ha of the land in the territory of Absheron peninsula.

Spontaneous build-up brings about the problems of development of the street and road network, which is the structure-forming city-planning carcass of the residential areas and regions of the city, and the high level of automobilization negatively affects the ecology of the city environment.

Under current conditions one of the solutions of transport infrastructure renovation in Baku agglomeration is revival and development of the ecologically rational mobility means (tramway, bicycle), which were widely expanded worldwide. Tramway is one the popular types of the light railway abroad. The light railway systems develop in the USA, Canada, Europe, and in the countries of the Asia-Pacific region (Narbekov, 2016).

The work on new master layout plans of the city in Baku agglomeration and the Plan of regional development of the Greater Baku till 2030 was finished only in 2014. In accordance with the new planning document, the emphasis is laid on development of the urban fringes and transition to polycentric development model. In this context consideration of new alternative concepts of transport infrastructure development with respect to tendencies of the previous period adopts special actuality. The aim of this work is long-term identification of the development perspectives of the transport system in the planning structure of Baku agglomeration (Fig.8).

One of the main points of the Master layout plan is development of the complex transport system. The objects of the transport infrastructure considered in the last master layout plan Baku were not implemented. From the other hand, the number of transport vehicles in Baku increased about 1 million for the last 11 years. 62,4% of the cars in Azerbaijan is concentrated in Baku. All this brought motor transport to the leading positions among the sources of air pollution in Baku. It also affects the congestion of the roads in the capital (Narbekov, 2016). Today, there are 108 cars for every 100 families in

Baku, compared to 25 cars in 2000. Despite the many transport infrastructure facilities (roads, bridges, bus station, etc.), the number and extent of traffic jams on the city roads grows from year to year (Fig.9).

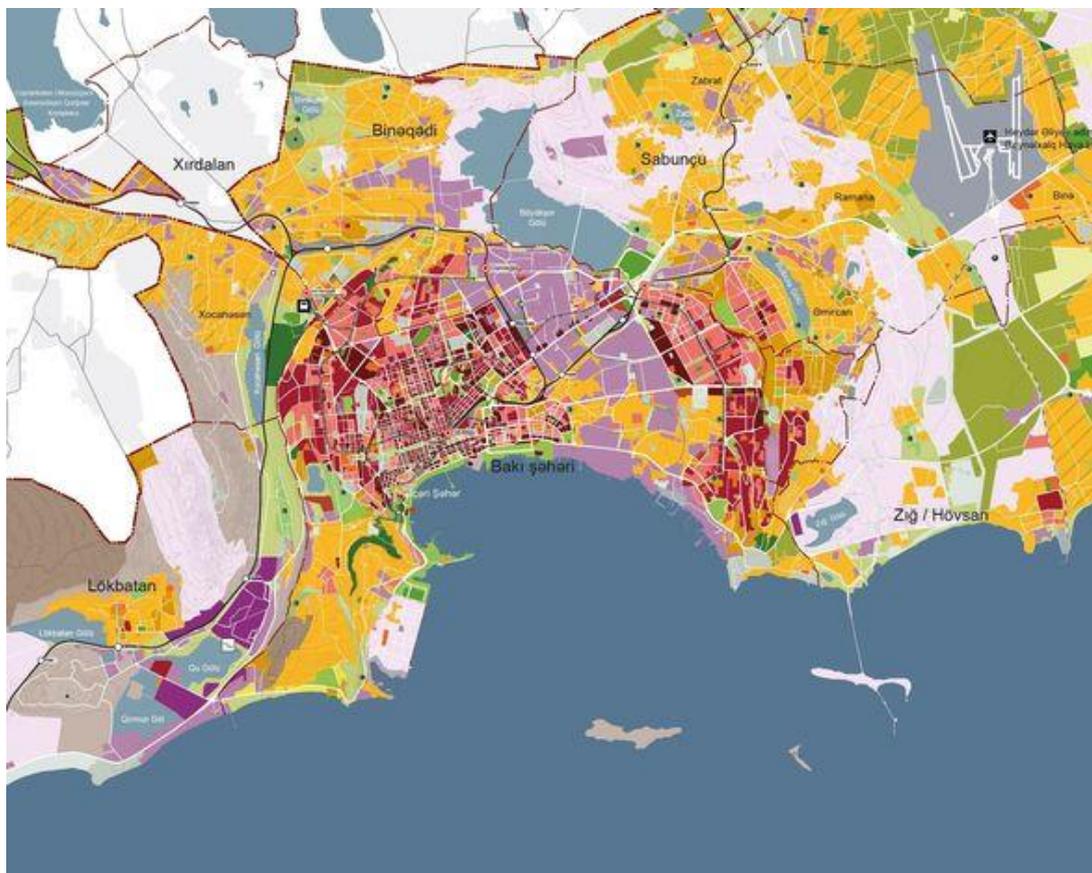


Fig.8. Greater Baku Regional Development Plan until 2030 (developed in 2014).
(picture from www.arxkom.gov.az)

Congestion – ‘traffic jams’ on Baku roads and highways became a part of the urban landscape long ago. Every day dozens of thousands of cars hit a traffic jam, lining up in kilometer-long queues on city highways. Sure enough, the traffic jam is a problem of all European megapolises, where large number of cars is concentrated. However, we consider that for us this is a poor consolation. Today we reached such a critical point that it became simply impossible to travel by automobile transport. (<https://arxkom.gov.az/sehersalma/regional-sxemler>).

So what are the main causes of traffic jams? They can be counted on your fingers.

Firstly, in present time approximately 700 thousand motor vehicles are registered officially in the city, 600 thousand of which are cars. Moreover we should not forget about the thousands of motor vehicles with regional registration numbers of the republic travelling on Baku roads. Most of them are almost constantly located and operated in Baku. It turns out to be an evident overkill for such a city as Baku. In order to estimate the road capacity the so-called indicator of comfort as the level of traffic congestion on the road is used. The current tension in traffic in Baku relates to the fact that today the level of street and road network overload is approximately 0.8 (for the central part of the

city it is almost 1.0), and the traffic density is approximately 100 cars/km. (i.e. 100 cars on 1 km of the road).

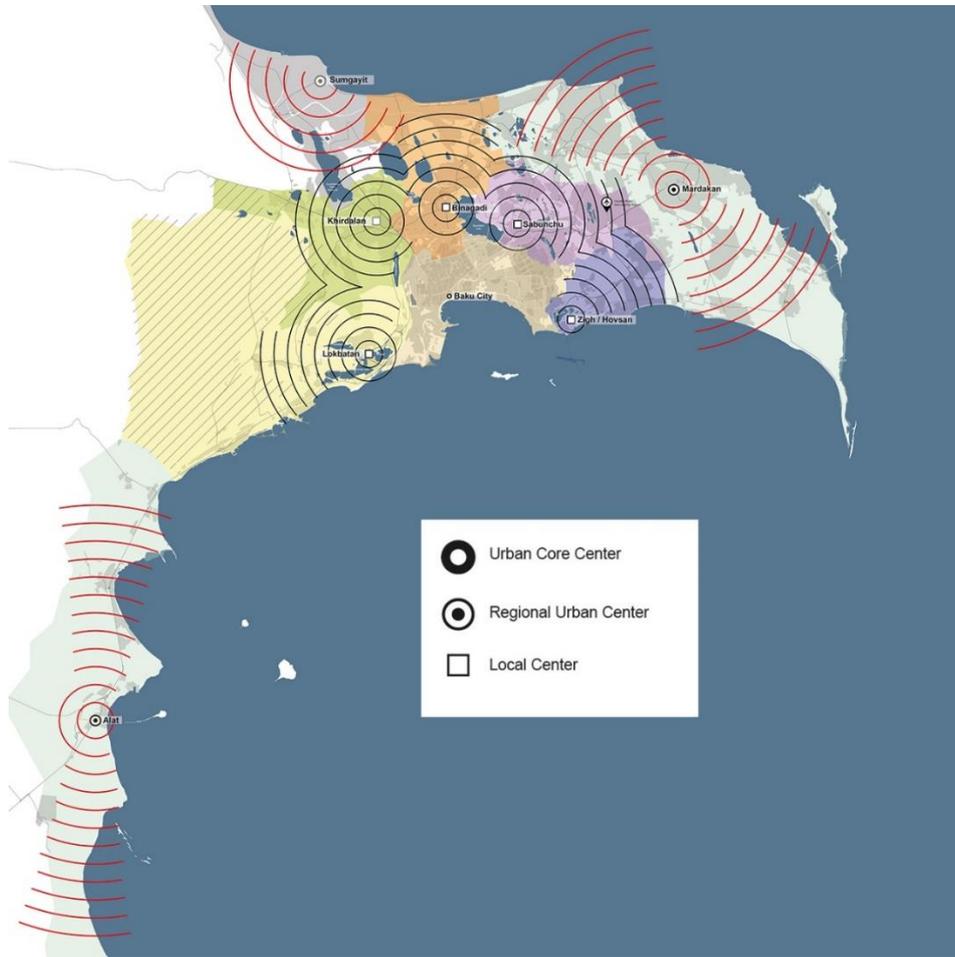


Fig.9. Organized Polycentric City (picture from www.arxkom.gov.az)



Fig.10. Integrated Mobility Approach of Baku (picture from www.arxkom.gov.az)

In order to reach the level of overload of Baku roads in the range of % 50-60 the traffic density should be close to 50 cars/km. At this density the level of street and road network overload will compose 0.5, and the transport flow tempo will be close to the modern level of automobilization approximately equal to 30 km/h (Fig.10).

According to preliminary aggregated calculations, in order to achieve this density, it is necessary to increase the road and street network of Baku by at least 2 times.

Secondly, the center of the city literally crammed with non-resident vehicles.

Thirdly, the transport infrastructure leaves a great deal to be desired: there is lack of modern roads and highways, road junctions, underground and above ground garages, crossings, and tunnels. 50 years ago under conditions of the Soviet Union planning the city, no one could imagine such a number of motor vehicles. For this reason during the build-up neither parallel formation of the necessary transport junctions nor the sufficient number of parking places were planned. In the automobilized cities the main consumer of the transport territory is cars which while being 'at rest', i.e. parking, require 20 m of open parking area for 1 place, but in motion process – 7-10 times more – 150-200 m. With a population density of 65 people/ha and a saturation level of cities with cars of 50 cars per 1000 inhabitants, the required transport area for their parking and movement is more than 5%. Considering the forecasted share of the roadway area size in % 7-9, it must be admitted that at a saturation level of 50 cars per 1,000 inhabitants in the largest cities, a traffic crisis during rush hours may occur (Kositsky & Blagovidova, 2007). The extreme congestion of roads in Baku lies in the fact that in comparison with the largest cities in Europe, the building density in the capital is on average 2.5 times higher, and the density of the road network is 7-15 times lower. In order to avoid the stalemates on roads it is necessary to intensify the transport territories by means of use of the underground and above ground spaces.

In Baku significant territories occupied by the low-rise build-up with dense network of the streets still remain (for example, 2-3 ha). However the multi-storey housing, grouped in large residential micro-districts (up to 25-30 ha), is built on the renewed territories. Concurrently most streets of the old quarters are eliminated, and the others are rebuilt into inner micro-districtal passways. However, the realization of park and transport junction project in the region of Teze Pir mosque can be an example of the rational use of the released space (Fig.11).

Increasing the density and number of storeys of new residential development, the formation of large residential micro-districts and industrial territories not divided by streets, may lead to a decrease in the share of streets and roads within the building boundaries from 20-25% to 10-15% in the future. As the result of this, the traffic intensity will increase and unauthorized street parking will be reduced up to the prohibition of the permanent storage of cars on the streets of the city.

In the most cities of the USA between one-third and a half of all the city territory (within the boundaries of the build-up) is the transport area. In the cities of the former Union, especially in the large ones, quite the opposite, the transport territories are relatively small as they compose no more than %20-25 of all territory within the boundaries of the build-up. For example, the street area per 1 inhabitant is 105 m in Los Angeles, 32 m - in New York, 12 m - in Moscow, 10 m - in St. Petersburg. (Volchkova, 2013). In Baku this indicator composes approximately 8 m. Transport territories in the USA cities are large, especially because of the small sizes of the residential areas, narrow street mesh, which contributes to the extensive development of the private motor vehicles.



Fig.11. Realization of park and transport junction project in the region of Teze Pir mosque
(Photo Timur Rzayev)

The total length of the roads in Baku is approximately 2200 km, and at least %90 of them are covered with the asphaltic-cement concrete. The total length of the main city roads is more than 1100 km. The road network density of Baku composes approximately 1.0 km/km^2 , while in European cities this indicator is no more than $8-10 \text{ km/km}^2$, and in the cities of the USA the road network density composes $12-14 \text{ km/km}^2$ in many cases.

The distance between the edge of the mainline of the highways and regulation line of the residential construction should be considered at least 50 m, and on the premise of use of noise protection devices - at least 25 m.

According to the regulatory requirements, the density of the main street and road network for the target time limit should be accepted within $3.2-3.5 \text{ km/km}$ of the territory of city planning. At the same time, the network density of the mass passenger transport line should be considered within $1.5-2.1 \text{ km/km}$ in the build-up of planning structure of the city while ensuring the maximum distance of pedestrian approaches up to the nearest public transport stop - 500 m.

Insufficiently developed street and road network, lack of main roads and streets, the deficit of which within the city limits with a total length of the road network of just over 2200 km is at least 1800-2000 km. Now everything is changing fundamentally, and the infrastructure of the city, in fact, remains the same, although in recent years the intensified attempts are taken to modernize it.

Fourthly, the parking shortage is evident. Cars are parked randomly, in rows near the sidewalks, making traffic difficult.

Fifthly, a significant number of traffic accidents, which cause serious difficulties for the normal traffic flow, are recorded in the city. In 2012 1068 RTA were registered in Baku, in which 330 people died and 1,126 people were injured. During this period more than 360 thousand road traffic offenses were registered.

At last, Baku dead-locks. We are already got used to traffic jams in the center of Baku, but why are there more and more traffic jams even in residential areas in the immediate vicinity of ring and main roads?

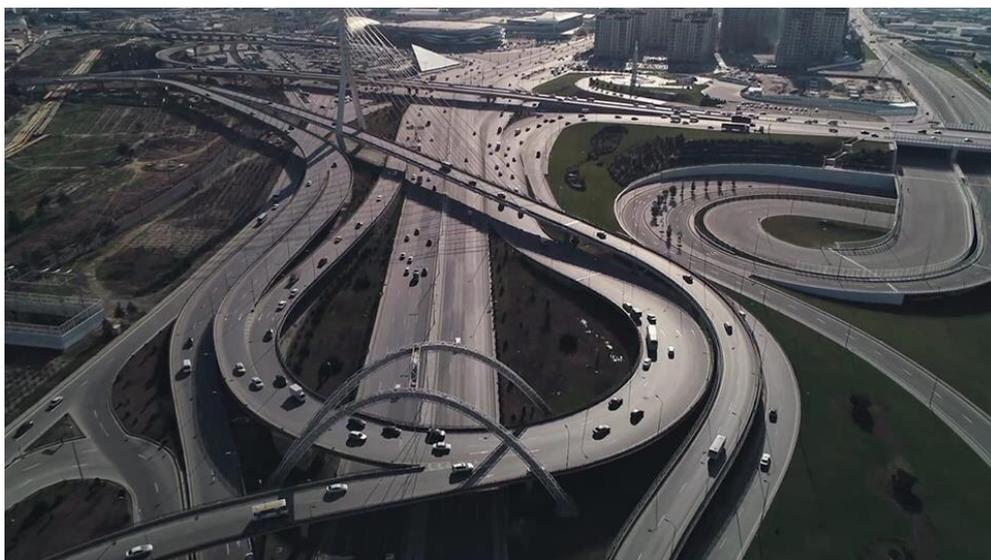


Fig.12. Transport junction located near the Koroghlu metro station
(photo from <https://vk.com>)

Today everyone is well aware that without the development of the transport infrastructure of the city, nothing sensible will come of it. No matter what other measures are taken. First of all it is necessary to develop the architectural and planning structure of the road construction, to reconstruct the roads and transport hubs, to construct underground passages, tunnels, to implement non-stop traffic flow at some highways and etc. The fact of the matter is that in the context of traffic management Baku is extremely complicated city. First of all this relates to the existing mixed radial ring system peculiar to most old cities (Fig.12).

Obviously, serious adjustments are required for the transport system to perform its functions. The main management of the architecture and city planning of Baku and the Ministry of digital development and transport had already taken and continue to take serious steps in this direction. Thus, more intensive road and bridge construction began. The largest commissioned facilities are the viaducts at the intersection of Tbilisi avenue and Salamzade G. street, and at the intersection of Ataturk and Bunyadov Z. avenues, and also the transport junctions near the '20 Yanvar' metro station, 'Koroghlu' metro station, and at the intersection of Azadlig and Bunyadov Z. avenues (the former Karl Marx square), as well as the mentioned before junction in the Teze Pir region, the first ring road, connecting the 22nd kilometer of the major highway of Baku – Astara with the Baku-Guba road at the entrance to the capital in the region of downhill to Bilejeri settlement. Appearance of the first ring road partially decrease the transport load on the rest nearby arterial road and streets.

For several years now, the ‘Koroghlu’ metro (the former Azizbeyov junction) – Haydar Aliyev International Airport – Mardakan – Buzovna – Bilgah 31 km long road has been put into operation.

In accordance with the project, the new trunk route has six traffic lanes in each direction between the ‘Koroghlu’ metro station and Sabunchu circle-junction with 5 thousand cars/hour capacity in peak hours, and four traffic lanes in each direction between Sabunchu circle-junction and International Airport with 4 thousand cars/hour capacity in peak hours. It is speedway and non-stop traffic highway. Of course, the new highway does not completely solve the problem of traffic jams, but it certainly plays a positive role in this regard. It is important not to lose sight of the fact that with the development of residential build-up, the nature of the congestion of urban highways gradually changes. The transport load on them grows. In this context, for example, it would be appreciated to organize the non-stop traffic on the main highways of the city, where in recent times the transport flow becomes too heavy. The main task of today is to achieve the transport outflow from the center of the city. (Plan of Regional development [e-resource], 2020).

Some time ago the idea of the so-called intercepting parking lots was born. Its meaning is to make guests and residents of Baku leave their cars at outstations, and reach the center of the city by the mass public transport. So, they say, it will be convenient for everyone. You will not be threatened with “traffic jams”, and the city center will not be overloaded with vehicles. For realization of this program nearby the metro stations it is necessary to allot lands for commuter parking lots. Truly speaking, anyone can hardly say today how effectively this program will work. As to our opinion, today there are few enthusiasts, who are ready to leave their car in the parking lot, pay for this, and after that crush in metro or bus, trying to reach the center of the city, although this idea can come true in the foreseeable future considering the construction of new lines and stations of the Baku Metro (more than 50 metro stations will be built by 2030). (Baku metropolitan railway. [e-resource]). Various offers are associated with increase of penalty charges for the parking violation and increase of parking fee. In general, to make travel to the city center paid. There are more radical proposals in this regard. For example, to transfer all the stores and warehouses from the city center to the suburbs, so that they do not attract trucks; or to build cultural, entertainment, food and drink venues only at city suburbs. However, such kind of offers occurs rather from hopelessness than from a real assessment of the situation.

Each country has its own accumulated experience of combating congestion on roads. Some of them might work for us, some might not. For example, in Rome they are trying to deal with traffic jams by offering residents to give each other a ride. This action is called ‘Share your car’. Anyone can sign up for the database on the municipal website, mentioning their route, phone number, address and preferences in regards to future passengers (the ability to smoke in the car, take small children and animals with you, and etc.). For those who make their cars available to neighbors, the city administration promises to issue a special card, on which sympathetic citizens will be able to receive discounts in shops, gyms, cinemas and supermarkets in their area.

This practice is used not only in Italy, but also in the other countries of the Western Europe. For example, in the capital of Spain, a special lane hedged by concrete divider is separated for those residents of the suburbs who goes to the center of Madrid by car with at least two passengers. Only scheduled buses, taxis and cars with at least three people can move along it. Neighbors from the Madrid suburbs cooperate with pleasure, and three or four people go to the center together. In Hong-Kong and Singapore the transport tax

was increased threefold, after that %14 of the car drivers sold their cars in a year. Everywhere everyone start again from the beginning.

For the fundamental solution of the problem of traffic jam in Baku city new architectural planning solutions, which demand huge material expenses, are required. In compliance with these solutions, the physical enhancement of the city roads and streets network, construction of relief road, and increase in the construction of the full transport junction is required. In order to increase the effectiveness of the construction and renovation of the roads and streets, despite of the complexity of the problem, it is necessary to start the solving of the issue from the city center however. To facilitate the solution of this issue, one of the ways is also to take control of the state regulation of the development level of automobilization. It is necessary to tighten requirements for the cars unroadworthy within the country, and also for imported cars.

5. Conclusion

The conducted analysis of location of the transport network and infrastructure, their hubs, entrances and exits from Baku, the capital of Azerbaijan, let us to identify the factors affecting the formation of its transport media and transport network. The geographic location of the city (Ijguzina, 2014), its proximity to the sea, mixed relief – all these affected the formation of the planning structure of Baku at the same time as building and organization of the transport junctions, roads and architectural space solution. Relying on the past experience and as the country integrates into the European community, the modern construction of the transport media objects takes place with respect to historical ways, as well as economic development of the state as a whole.

With the purpose of increase of the transport availability between the residential areas of the agglomeration (Dubovik, 2013), in accordance with the Plan of the regional development of the Greater Baku, the construction of new highways, the length of which exceeds the previous indicators by 42%, is considered. The significant attention is paid to the development of Baku metro system network. The length of the network is planned to be prolonged 3.4 times in comparison with 2011.

The complex of measures on modernization of the current road-transport network, development of the aboveground public transport, optimization of the parking operations, enhancement of the metro system network, organization of the route of the interurban railway connection, improvement of the management system of the urban transport led to the more effective functioning of the transport infrastructure (Shmidt *et al.*, 2016). However, there is a number of problems related to the ecology, social adaptation of the physically disabled citizens, sanitary requirements of the build-up, city economy, effective land use and etc. These tasks afflicting the modern urban planners can be resolved by using the complex approach consisting in historical analysis of urban evolution, choice of assessment and forecasting methods, research of the perspective development, effective management on all stages of preparation and realization of the project proposals.

It is considered to construct the tramway line along the Baku seaside. In the long-term perspective it is planned to render the railway line to Haydar Aliyev International Airport of Baku, and also to the touristic centers Shahdagh and Gabala; in present time the efforts are taken to design these lines of communication.

Taking into consideration the wishes of the citizens and car users, and also taking into accounts the high level of automobilization in the capital city, development of the

alternative ecological types of transport (tramway, electrobus) has special actuality. Besides, the conducted analysis showed the effectiveness of tramway line use in relation to the economy of city roads spaces, and also freight capacity of this type of the transport.

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