Building-Bridges and Building-Platforms as Impact Into Sustainable Development of City Architecture

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Abstract. Building-bridges and building-platforms significantly contribute to the resolution of two most complex problems large cities suffer from: recurring traffic jams and dramatic lack of free territories for building development. Building bridges over various extended obstacles of the technogenic (motor and rail roads) and natural (rivers, cloughs, etc.) remains one of the most urgent tasks of forming urban traffic system. Bridge erection is fully financed by state structures but it does not provide any direct economic return. Due to restricted public funds bridge building can last for years. To resolve the problem as fast as possible, one suggests attracting external investments by means of constructing a new type of buildings called “building-bridges”. The bridge part of the building is included in the urban traffic system, useful building areas which can yield early income are assigned to the investor for use. Due to this the second problem - the lack of free territories for building development - is resolved. The development of building-bridge structural systems allows forming large spaces of platforms for building development, garden square improvement, sports grounds and parks enhancing the city ecology over the territories of access routes to railway stations and some industrial territories within the city.

1. Introduction
The sustainable development of city architecture alongside with a wide range of problems covered by this notion is connected with the establishment of transport comfort of the urban environment and, consequently, with the ecology improvement [1]. Most large cities not only in Russia but in Europe as well experience great difficulties with the provision of motor transport free transit in their territories. One should note that medium-sized cities start experiencing the same problems caused by the growth in the number of drivers. In many cities the key obstacle are railroad crossings: the queues to them are sometimes enormous and can persist for hours. Another problem issue is closely related to single-level crossings of urban motor roads. Continuously occurring traffic jams, especially at peak hours, lead to psychological stresses of both the residents and drivers and cause a significant deterioration of the urban environment situation as well.

2. Relevance and issue scientific significance
Recently, great efforts have been invested into transport situation improvement, namely, by building transport junctions with several levels at road crossings, elevated overpasses in the points of road intersection with adjacent streets, developing passenger public transport, both underground and surface, which should make the traffic of private cars not so busy, etc. However, the efforts made lag behind the pace of vehicle-to-population ratio growth and thus result in temporary or local results. In
some period of time the vehicle-to-population ratio will stabilize but the transport issue would not be resolved with the help of the undertaken measures. Two circumstances can explain this phenomenon. One of the reasons is that in any city a street&road network is always larger than public transport networks. That is why the demand for private cars will be always rather high in those cases when there is no public transport or it is not comfortable to use it. This is intensified by the break of a street&road network with a large number of the aforementioned extended obstacles without a sufficient number of bridge crossings. The aforementioned circumstances caused the occurrence of jams at news roads the pass-through function of which is quite soon stop being fulfilled because of traffic flow from dormitory districts. These flows were not be directed to motor roads if there would be alternative routes along the local streets which are not divided by extended obstacles [2].

In the largest cities, such as Moscow, a total lengths of such obstacles (rivers, cloughs, railroads) cutting road networks of big cities, reaches hundreds kilometers. To connect the divided road networks, one will need to build two or three hundreds of bridges per each hundred kilometers (in addition to the existing ones). Building traditional bridges requires enormous financial costs. Here one should take into account that a larger part of bridges should be built in dormitory districts where heavy haul vehicles are not allowed. That is why the bridges should be intended for motor cars and light commercial vehicles which is significantly cheaper than building traditional types of bridges intended for heavy load. To attract the investments for construction which could be easily paid off, in addition to road ways, there should be the premises where it is recommended to locate the companies necessary for the population living nearby (shops, cultural, sport, household and other companies). Therefore, for successful implementation of the project on connecting a road network without attracting public funds, one needs a new type of erections “building-bridge”, the road way of which is transferred to the city ownership while the premises are transferred to the investor.

Besides invincible obstacles for road transport, the cities suffer from a significant “pressure” on the part of railroads the exit routes to which, alongside with the households of distributing and freight stations take away large territories of the city and simultaneously deteriorate the environmental component of the urban environment on noise, emissions and other pollution types [3, 4]. This problem is only at the initial stage of resolving at the level of urban management and architectural design both abroad and in Russia [5].

The lack of territories for new building development is one more reason to decrease the sustainable development of city architecture [6]. Getting a land lot for these purposes seems to be rather difficult and expensive issue. The problem is resolved by means of the demolition of old buildings, mainly, by means of resident evacuation or inclusion of regional territories’ in the general area of the city as it was done in Moscow by connection of Troitsk and adjacent large territories of the Moscow region.

3. Theory
One of the ways to resolve these problems is constructing building-bridges and building-platforms; the latter, for example, can be located over access routes to railway stations, distributing or freight station of railroads. The waysides can be also covered by such a structure owned by the Russian Railways facilities and some industrial companies. This problem has been studied and resolved for many years at the Chair of Architecture of Moscow State University of Civil Engineering (NIU MGSU).

A building-platform is an overhead large span structure elevated above ground for the height defined by the function of the facility beneath [7]. If these are railroads, the building-platform should be elevated by approximately 7.5-8 meters above ground to organize electrical grid functioning and other railway equipment.

The building-platform can have a various number of floors and height. The simplest case is a platform having an overall floor height of approximately 1 meter at the span of 20 m where a landscape park is organized [8]. The building-platform can have two and more floors. In this case the volume and areas of the internal space are transferred for necessary city functions.

If one considers the site plan of Moscow, there one can define those territories which may be used for building-bridges and building-platforms. As railway stations in all large cities of Russia and Europe
are historically located in the central part of such cities, the building-platforms can be in the first place be located over the territories occupied with access routes as it is seen in Figure 1.

![Image of railway stations in Moscow](image)

1-Kazansky railway station, 2- Leningradsky railway station, 3- Yaroslavsky railway station, 4- Rizhsky railway station, 5- Savelovsky railway station, 6- Belorusskiy railway station, 7- Kievsky railway station, 8- Paveletsky railway station, 9- Kurskiy railway station (thesis of Ye.I. Kocheshkova)

Figure 1. The layout scheme of railside territories and railway roads in Moscow

One of the most important aspects of using the internal space of a building-platform is a motor car road paved inside and connecting city districts beyond main roads and eliminating traffic jams on them. At the same time the internal space can be used for various functions of the urban economy: car parkings, storages, retail, etc. The spaces of building-platforms located along the structure edge, i.e., having natural light, they can be occupied by offices, hotels [9], administrative organizations, etc. The scope of building-platforms can locate double floor height areas for high-rise premises as well as forming large two- or three-floor open yards where a large number of premises requiring natural light can be located.

The most important factor improving the urban environment ecology is the possibility to organize stacks in such structures. Such stacks collect and filter emissions from railroad facilities work thus supplying cleaned air in the city.

Building-platforms facilitating the secondary use of urban territories can not only double or triple their size but also providing large areas for construction development [10]. Construction can be residential or public, except for children institutions with the toughest sanitary norms. At this special measures on providing sanitary requirements and safety requirements can provide the construction of a whole set of educational institutions. The important factor of selecting the construction type on the top of building-platforms is, in the first place, the necessity of satisfying the demand for the construction area in terms of the functional intended use of the buildings under construction. In the next place, it is providing the view and perception of a new building located on the platform surface from the ground level.

4. Suggestions and introduction results

Fig. 2 presents the architectural&design and composition solution of the building-platform over the distributing station of Rizhskaya railroad not far from the station Losinoostrovskaya.
This solution represents the case when the building-platform is surrounded by adjoining buildings of various types from both sides. On one side the territory was developed by low- and mid-rise buildings and high-rise buildings on the other side. Both residential micro-districts remain without any considerable green zones. The architect resolves the task in compliance with the residential environment needs and with the account of visual perception of such a massive structure. A road is paved through the platform, and this road connects residential quarters divided by railroads. On the side of increased construction at the platform it is planned to construct 3- or 5-floor office buildings while on the side of low-rise construction a landscape park is made on the platform to provide a green zone in a residential area.

A long building-platform over access routes to Belorusskiy railway station is designed as a two-floor erection locating various buildings: theatre, sports and recreation center, group of residential houses and an office&hotel complex finishing the general composition. On the top surface a landscape park is made between the buildings. Here there is a boulevard with a mirror-like surface and fountain uniting the erections on a compositional level (Figure 3)

The building-platform can overlap several roads passing near each other as it is designed at the circular railway between streets Zvenigorodskoye Shosse and Vavilov street. This buildings locates a large field-and-track riding hall and a car passway combining the apartment block divided by the railroad (Figure 4).
Figure 4. Building-platform over the circular rail road connecting Zvenigorodskoye shosse and Vavilov Street with a field-and-track riding hall. Arch. Antonova T.

The building-bridge is an overhead long-span erection with two and more floors with a mandatory traffic area at the low level [12]. The floors are completed with various areas having the functions necessary in this micro-district: parkings, storages, retail, offices, etc. (Fig. 5) [13]. Building-bridges can have various spans: short-span –up to 25-30 m, 35-50 m - medium-span and long-span from 60 to 100 and more meters. Each type has its own design basis [14, 15, 16, 17, 18, 19]. Building-bridges are intended for connecting motor roads anywhere thus making main arteries less busy due to the use of transport “capillaries” created with their help.

Figure 5. Functional content of a longspan building-bridge

1- transit of engineering communications, 2- motor road, transport connection, 3,4- buffer premises - technical floor, car parkings, storages, etc., 5,6,7- premises with various intended use, 8- accessible roof.

The structural basis of small building-bridges as the least expensive is a composite reinforced concrete consisting of reinforced concrete slabs with the arris in the form of light metal bridge beams.
with the height of 1 meter. The dimensions of reinforced concrete overlap are approximately 20x2 m. These precast slabs ready for installation make the interfloor overlapping. The structure of medium-span building-bridges is based upon the principles of “load-bearing floor” where all vertical and horizontal components are united in a single spatial case. Then, under such floor with short spans between partition walls (4-5 m) all the lower floor is located without intermediate supports. Long-span building-bridges has a structural basis in the form of multi-floor load-bearing bridge beams inside the constructional depth all the building floors are situated (see Figure 5).

5. Conclusion
As a conclusion, one can point out to the fact that at the modern stage of forming a sustainable development of city architecture the suggestions developed by Moscow State University of Civil Engineering are the most relevant, not to mention that the society of foreign architects tries to stick to this way [20]. The acknowledgment of the need to take a crucial solution of transport problems in the cities, ecology improving, obtaining additional areas for building development as the secondary use of already developed territories led to the elaboration of suggestions on populated bridges [21]. However, most suggestions are limited by bicycle and pedestrian traffic, which cannot facilitate the resolving of the specified problems. The important factor supporting the idea of constructing building-bridges and building-platforms with motor transport passage is the factor of interest on the part of potential investors with the acquisition of premises for lease. The latter significantly decreases financial burden born by city budgets.

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