Principles of Formation of Aboveground Parking Lots as a Part of Residential Building or Complex

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Abstract. The article deals with the problem of parking and storage of personal transport in multi-storey residential development areas. Using of underground parking under a building or yard may not always be the most profitable solution. Especially taking into account that the nature of the soil in the largest megacities of Russia is very complex and it leads to a strong increase in the cost price of the project. Options for organizing above-ground parking are proposed and analyzed. The advantages and disadvantages of modern free-standing parking lots are described in the article. Examples of built-in attached parking lots within a residential group are demonstrated too. The advantages of automated parking lots built into the lower floors of high-rise buildings are listed. Project proposals are presented that demonstrate the possibility of placing automatic Parking directly in the lower floors of a residential building.

1. Introduction
One of the most serious problems of most megacities, both in Russia and in other countries, is the parking and storage of cars problem. The size of parking spaces increases in an arithmetic progression as the amount of storeys of residential buildings and the amount of private vehicles. As a result of the increase in the amount of cars, most of the outdoor areas between buildings are occupied by private vehicles. This applies to both established urban areas and new construction areas. This leads to the fact that the roadway of most streets and driveways is used for traffic only by 30-50%, and this, in turn, leads to a corresponding reduction in the capacity of the road network, a lack of free space, a high risk of accidents and environmental degradation of the entire district.
To avoid this phenomenon, in the previous decade in the most respectable areas, designers switched to the device of underground parking, which, according to the legislative regulations of the time, were located in several tiers directly under the building. However, this practice has shown the irrationality of such solutions, because such underground parking facilities were too expensive due to the complexity of their design. Currently, most of underground parking lots are designed under the territory of the courtyard of a residential group.

However, this principle of car placement is also not always acceptable, since it is also expensive and has a significant impact on the cost of housing construction. The soils of the largest megapoles of the Russian Federation (Moscow and Saint Petersburg) are very complex, abounded with clay soils and quicksand, which creates additional difficulties in underground work conducting. The organization of underground parking contains a complex ventilation system with access to the surface, requires an additional number of fire exits to the surface of the yard. These factors greatly limit the possibility of creating interesting landscaping in the yard.

Thus, it is worth paying attention to the options for aboveground parking as part of a residential complex.

2. Theoretical part

Aboveground parking can be organized according to several principles:

1) separate building;
2) aboveground parking, which is part of a residential group due to the built-in attached volume;
3) aboveground automatic parking that is part of a residential building.

A multi-level parking lot is a structure that is designed to accommodate a large amount of cars in a limited area. Cars are arranged in tiers above each other, moving to the desired tier is carried out using ramps, elevators or lifts. The parking lot may include additional rooms for car maintenance and specialized rooms for staff. Multi-level parking lots can be divided into two groups according to the time of car storage: for short-term and for long-term storage.

Pre-erected free-standing parking lots are built in a few months using lightweight structures (mostly metal), which saves not only time, but also money.

Free-standing parking lots on a metal frame have a number of advantages over concrete ones, such as: short construction time at any time of the year; low cost of construction and maintenance; technology and efficiency of installation.

Such parking lots can perform not only the function of storing transport, but also be an interesting art object of urban space, successfully complementing the surrounding buildings. Unfortunately, at the moment in Russia, this type of construction is almost not of artistic value, because the main thing in this approach is the price of construction.
Parking lot attached to a residential building can be a variant of an alternative option to a separate standing parking lot. Such parking lot, being an independent unit can become part of the overall spatial solution of a residential complex according to the planning decision. Its cost can be comparable to the cost of a separate standing parking lot, it can be completely above ground or have one or more underground floors. Such parking lots, as well as separate standing ones, can be equipped with ramps or lifts.

At the same time, its architectural and spatial solution must be compositionally linked to the residential group that it belongs to. Naturally, the personal cars that will be placed there must belong to the residents of this residential group. This solution of ground parking lot can be very profitable for new residential areas of large cities and megacities in Russia, as it will not only free the yards from parking lots, but also can bring significant architectural diversity to the monotonously repeated alternation of residential sections. Parking of this type can be part of a complex of public space in a residential group, for example, in a stylobate part that compositionally interacts with residential units.
If the yard space is very small, or it can not be occupied there are possible solutions, including the placement of parking lot spaces on the first floors of residential buildings. This option may be particularly appropriate for dense high-rise construction. You can find many successful examples of such parking lot arrangements in the world practice. They can be found in office buildings, hotels, residential buildings, and apartments. They can be of open or closed type and their compositional solution can be very harmoniously combined with the volume of the building.

Figure 12. Kowloon East building in Hong Kong
Figure 13. Marina city residential complex, Chicago, USA
Figure 14. Baiyoke Sky, Bangkok
Figure 15. Car Park Tower, China (project)

However, in Russia there are no regulatory documents for the design and construction of parking lots of this type. Architects and urban planners are aware of the need to introduce them based on an analysis of the current situation, because the height of buildings in megacities is growing rapidly.

To date, the issue of amendments that allow and normalize the construction of such buildings is handled by the Central research and design and experimental Institute of industrial buildings and structures, located in Moscow. It is necessary to carry out quite complex work, since it is necessary to take into account the requirements imposed not only for parking, but also for residential floors located directly above it.

3. Suggestions and recommendations

Car parking in the lower floors of a residential building must be automated. The construction of parking in the lower floors of the building has a number of advantages: compact placement of cars and the absence of ramps, elevators and stairs give a 40% greater compactness of parking compared to other types of parking lots. Mechanized car parks can be located on complex, narrow sections of irregular shape.

The main problems that can be encountered when designing parking lots as part of the building volume are:

1. Emission of harmful substances when the engine is started and warmed up;
2. Noise pollution;
3. Fire safety.

When installing above-ground parking under the volume of the building, it must be in closed structures. If you make it open, then solving the issue of exhaust gases will require either creating a forced ventilation system for residential floors, with no air exchange through the windows, or an expensive fire extinguishing and smoke removal system in the floors where the parking will be located.

The modern automated car placement system has a number of advantages:
• High density of car storage. In order to use the space efficiently, the height of each level is about 1.7 m. The parking lot capacity can vary from 10 to several thousand cars. We accept or issue two cars at the same time.

• Minimising emissions of harmful substances, as cars are stored with the engine no longer running.

• Low depreciation cost, long life of the system.

• Economic advantage: the construction and maintenance of this type of above-ground parking will cost 50% less than the construction of a classic underground parking of the same volume.

• Convenience of using. According to the experience of world practice, it takes only a few minutes to feed the machine, despite the impressive storage volumes.

• The safety of cars. The automated system is equipped with all the necessary sensors for accurate transportation and storage of cars, and the absence of people in the storage area eliminates vandalism.

• This system provides a low noise and vibration coefficient, which significantly expands the scope of its application.

Despite the listed advantages of automated parkings, they must be separated from residential floors by a technical floor. The technical floor can have a lower height compared to residential floors and serves for the location of all utilities, both parking and the residential building itself.

From the point of view of external composition and perception of the building, the volume of built-in parking lot can have an interesting architectural solution. Since such a parking lot does not need window openings, it can have the visual properties of a certain base, a podium for a high-rise building. As an example, the project proposal for an office building with apartments in Minsk, Belarus (Pic. 16, 17, 18) Built-in parking lot in this project is divided into 2 zones: parking for residents and a separate parking for employees of the central office building.

Figure 16. Project proposal for the introduction of parking lot with the building volume structure. Architect A. Muratova, I. Melnikova.
4. Conclusions
At the current level of motorization, open parking lots can not meet the need of residents of a residential building for temporary storage of vehicles. There is a need to design new types of parking lots that provide a high degree of compactness when located near a residential complex. Increasing the distance from a residential apartment to a parking lot creates a strong discomfort for usage.

The solution to this problem can be the placement of parking lot as part of a residential building or complex. Such parking can have an interesting architectural solution that will be well perceived and help improve the characteristics of the surrounding spatial environment.
By freeing the space of city courtyards from clutter with cars, we are getting closer to creating a comfortable urban environment for living and recreation, which is especially important in modern large cities.

5. References

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