New type of hybrid housing structure for the city of Yerevan

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Abstract. The accumulated development experience in Yerevan over the past century (1920-2020) is analyzed taking into account the practice of housing designing and building of the past stage. Based on the analysis of the existing development experience and the studied material, a number of significant shortcomings in the space-planning solutions available for the housing currently in exploitation are identified.

Using the principles of sustainable architecture and the foreign experience, we offer the suggestions for the new type hybrid house structure with the possibility of variations in the number of stories and planning solutions. The expected effectiveness of these proposals’ implementation in the development execution in Yerevan is assessed.

1. Introduction. Analysis of contemporary foreign experience

One of the main directions in modern housing architecture formation remains the problem of finding the optimal solutions to create a comfortable living environment for the main category of the inhabitants.

Today, among the main principles of shaping the architecture of residential structures are: the principles of sustainable architecture, the principle of autonomy provision, the principle of land resources’ optimal use, the principle of dynamic forms development, the principle of residential structures’ spatial composition uniqueness [1].

Based on the accumulated experience and trends in creating the sustainable architectural solutions, the following principles of creating a sustainable architecture can be emphasized [2]:

- Maintaining the ecological balance between natural and artificial components,
- Application of waste-free or low-waste industrial and construction technologies,
- Reducing resource consumption, improving the urban planning solutions through the energy-efficient technologies’ use for the renewable energy sources application,
- Application of structural and spatial solutions that fit into the context of the natural environment,
- Erection of cost-effective buildings and structures,
- Increase the comfort of people by improving the functional, microclimatic and aesthetic parameters of the environment, as well by using smart technologies,
- Introduction of nature components into the building structure,
- Focus on local natural, landscape and cultural conditions,
- Adaptable to natural, climatic and anthropogenic challenges and risks [2].

We considered the influence of some of these principles in the architectural form.

The modern stage in the formation of residential complex architecture can be characterized by an appeal to natural forms. The inclusion of nature elements into the structure of residential buildings can be implemented by various architectural means: in the apartment interior, by means of the landscaping terraces use, winter gardens, etc.; in the structure of a residential building, by means of vertical and horizontal landscaping of building facades, roofs, open and glazed atrium spaces, maximum disclosure of internal spaces to the external environment, glazed openings of a large area, extensive terraces, balconies of various configurations and sizes; in the structure of urban development, by means of horizontal and vertical buildings with open green floors, multi-level atriums. One remarkable example of an organic combination of natural and artificial forms is the residential complex “Vertical forest” in Milan (architects Stefano Boeri, Gianandrea Barreca and Giovanni La Varra). Two towers of 80 and 112 floors of 110 and 76 m are covered with green spaces, which determined the original design of the building facades. A number of Ken Young’s works, who also used the principles of continuous landscaping in the structure of the building: hanging gardens form the facades of a 26-story tower (EDITT tower, Singapore, 2010), which is designed so that its functional purpose can vary from office to residential. All modular elements of the structure are assembled mechanically meaning that the movable walls make it possible to change the facade surfaces according to changing needs [3].

An example of using the natural environment elements in the space of a residential building is the Hundertasser house “Hundertwasserhaus” (architects Friedensreich Hundertwasser and Joseph Krawina), where green surfaces on roofs, facades, balconies and terraces, two-light glazed spaces, winter gardens, winter courtyards have been used. All these planning elements of a residential building help to increase the comfort of living and improve the environmental background of a residential building [3].

The principle of ensuring the autonomy of residential structures is based on reducing energy consumption in the residential buildings operation, minimizing the use of traditional energy systems and actively used autonomous systems with alternative renewable energy sources (solar collectors, solar cells, wind devices on facades or roofs, geothermal and other natural systems). The use of autonomous energy generation systems (both passive and active) together with energy-efficient solutions for the space-planning structure of houses increases the economy and comfort level. The operation of the solar systems’ specialized equipment, in turn, affects the formation of modern housing both during the existing housing stock reconstruction and the newly built houses [4].

2. Analysis of the housing current state in Yerevan and the proposals for a new hybrid type of housing

In a number of works [4, 5, 6, 7, 8, 9], the authors analyzed the accumulated experience of development in Yerevan over the past century (1920-2020), considered the practice of designing and building housing of the past stage, as well as a number of works by other authors [10, 11, 12, 13, 14, 15, 16, 17] dedicated to the same problem.

The analysis of the considered material shows, that there are a number of significant drawbacks in the operated housing in Yerevan, namely:

1. The absence of an elevator in residential buildings above 3 floors (at a time when, according to building codes, an elevator is required to be installed above the planning mark of 1000 m in the climatic conditions of Yerevan),
2. An obliged organization decision of the entrance to the staircase-elevator unit, usually, after lifting ≈ half of the flight of stairs, leads to an uneconomical increase in the planning level of the first floor by at least ≈ 90 cm, and also causes some discomfort to the residents,
3. The absence of complete maintenance of the roof, even if the roof is flat,
4. A single passenger elevator in the stairwell in residential buildings above 5 floors (usually 9-story residential buildings). If the elevator is stopped for repairs, there are difficulties in unusual situations – in cases of patients’ transportation on stretchers, transferring oversized cargo, etc.,
5. The presence, as usually, of 1-2-room apartments that do not have through, corner ventilation,
6. The solution of summer facilities in the form of attached verandas, mainly in 5-story buildings,
which leads to their mass glazing, and negatively affects the architectural appearance of the
building, as well as leads to natural lighting and darkening disturbance of the residential
facilities adjacent to the veranda,

7. Dominance of uniform monotonous solutions of the entire residential development due to the use
of a single type of sectional house, set by the house-building plant products.

A new type of housing for the city of Yerevan was also developed taking into account the
sustainable architecture principles. The proposed structure of a new type of hybrid house with the
possibility of variations in number of floors and planning solutions is considered by the authors not as
the only direction for solving the housing problem as it was in the past, but as an addition to a diverse
range of proposals [4].

The authors proposed:

- In the structure of the building on the 1st and 2nd floors, the place apartments of the
  "maisonette" type ("duplex") with an entrance-exit from the street, without connection to the
  staircase/staircase-elevator unit. In front of each apartment, a green area is provided on both
  sides (front garden, garden with a depth of max ≈ 9m, taking into account the fire protection
  requirements provision). There can be basically several solutions (Figure 1.a).

- Organization of entrance and exit to the apartments through the open galleries. The proposed
  solution will contribute to creating a more comfortable and eco-friendly home and living
  environment in general [4]. Residential buildings will have two stairwells instead of the
  previously traditionally used four ones. In residential buildings, an elevator unit will be
  provided with 2 elevators (passenger and cargo-passenger) instead of one, which will
  significantly increase comfort - when repairing one of the elevators, the other will serve
  residents. The presence of a cargo and passenger elevator will also significantly increase the
  comfort level for the residents. Finally, instead of 4 elevators, the building will have only 2. If
  galleries are used, the hygienic quality of the air environment on the way in and out of the
  apartment will increase. Entrance and exit to the stairwell from the main platform will allow
  more variable placement of the house on the site. The entrance and exit to the autonomous
  elevator unit should increase the comfort for residents. Since the combination of the staircase
  and elevator unit will lead to the mandatory overcoming of half a flight of stairs to enter the
  elevator (Figure 1.b, c).

- The presence of a flat operated roof can be used both for the installation of photovoltaic systems
  (energy-saving roof), and for the recreational area organization.

- Landscaping of courtyard areas around the perimeter of ≈ 9m will also provide protection from
  noise. The presence of a green zone will help to improve the climate of the residential
  environment.

![Diagram](a)

![Diagram](b)
Figure 1. Structure of hybrid houses, sections.

Figure 2. The structure of a hybrid house, a master plan example.

Figure 3. Hybrid home master plan options.

Summary
Analysis of the housing current state in Yerevan has been carried out, with several issues being identified.

The proposals for a hybrid structure are as follows:
1. It is recommended for a residential house to be consisted of two autonomous combinations of apartments, differing in the type of “entry and exit” arrangement: the entrance to the apartment directly from the street and entrance from the gallery (Figure 1.b, c).
2. All apartments are usually offered to place “maisonette” (“duplex”) two-level-type (Figure 1.a, b, c; Figure 2).
3. It is recommended to use an earthquake-proof compartment apartment with a length of about \( \approx 60 \text{ m} \) as a basis.

4. The residential building is proposed to be surrounded from two (optionally from three or four) sides by a zone of green spaces (\( \approx 9 \text{ m} \) deep) and along the front by the sections which width corresponds to the apartment facade size. Each apartment will have two sections (with an entrance from the street and from the courtyard). This principle will also ensure proper care for the entire area surrounding the residential building (Figure 2, 3).

5. Around the green zone, it is proposed to organize parking for personal use by the residents (Figure 2, 3).

6. A residential building will usually have a flat roof that is used to get solar energy, provide a recreational zone to the residents, etc. (Figure 1.a, b, c).

7. The gallery is proposed to be located usually through the floor (Figure 1.b, c).

8. The residential building will have 2 staircases (instead of the traditional 4 in the case of the apartment entrance from the staircases) (Figure 2).

9. Elevator-free 4- and 6-story houses are proposed, respectively, with the residents’ lifting to the 3rd and 5th floors (Figure 1.b).

10. Residential buildings in 8, 10, 12, 14, 16 floors will be equipped with 2 elevators: passenger and cargo-passenger at one of the stairwells (staircase-elevator unit) or elevator unit, solved independently (Figure 1.c).

The proposed solutions for organizing the structure of a hybrid residential building will allow to save the cost of two staircases (only 2 instead of 4) for each residential building, as well as save on the number of elevators (2 instead of 4) with a significant increase in comfort. In practice, each of the residential buildings above 6 stories in the traditional sectional structure should have one passenger elevator per section.

It should also be noted, that entering the apartments through the air zone will help solve many hygiene and sanitary issues.

In the context of the residential formations’ modernization and development problem in the city of Yerevan, it is also proposed to allocate the territories for ethnographic zones and their pedestrian sections [4, 18, 19, 20].

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Acknowledgements
This work has been carried out in the frame of the “Architectural issues of the creation of ethnographic park-museums of the Armenian people” theme and in the frame of the “Creating the ways for sustainable urban, architectural and construction complexes development in Republic of Armenia and elaboration of directions with use of permanent monitoring system” programme, financed by Science Committee of Republic of Armenia.