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Architectural and engineering aspects of Housing Care Programme for Homeland War victims

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Subject review

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Architectural and engineering aspects of Housing Care Programme for Homeland War victims

The Housing Care Programme for Homeland War victims, initially started under the patronage of the Ministry of Development and Reconstruction, has been implemented since 1997 on the entire territory of the Republic of Croatia. Main aspects of the housing stock built in the scope of the programme are described: structure of dwellings, structure of dwelling prices, and quality of architectural expression. Causes of building damage are listed, typical problems arising during construction and subsequent use of the dwellings are described, and an overview of the most common groups of deficiencies, according to the place of origin, is provided.

Key words:

Housing Care, construction of buildings, structure of dwellings, dwelling price, architectural expression

Pregledni rad

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Arhitektonski i građevinski aspekti stambenog zbrinjavanja stradalnika iz Domovinskog rata

Program stambenog zbrinjavanja stradalnika iz Domovinskog rata provodi se od 1997. godine na cjelokupnom području Republike Hrvatske započet pod upravom Ministarstva razvitka i obnove. U radu se opisuju glavni aspekti stambenog fonda izgrađenog u Programu: struktura stanova, struktura cijene stanova i kvaliteta arhitektonskog izričaja. Navedeni su uzroci nastanka šteta na zgradama, opisani karakteristični problemi nastali tijekom izgradnje stanova kao i oni nastali u uporabi uz pregled najčešćih grupa nedostataka prema mjestu nastanka.

Ključne riječi:

stambeno zbrinjavanje, stanogradnja, struktura stanova, cijena stana, arhitektonski izričaj

Übersichtsarbeit

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Architektonische und bautechnische Aspekte der Wohnversorgung von Opfern des Heimatkrieges

Das Programm der Wohnversorgung von Opfern des Heimatkrieges wird seit 1997. auf dem gesamten Gebiet der Republik Kroatien durchgeführt und wurde unter der Leitung des Ministeriums für Entwicklung und Wiederaufbau begonnen. Die Hauptaspekte des im Programm erbauten Wohnbestands werden dargestellt: Wohnungsstruktur, Wohnungspreisstruktur und Qualität des architektonischen Ausdrucks. Ursachen entstandener Gebäudeschäden sowie typische Probleme während des Wohnungsbaus und der Nutzung werden beschrieben und eine Übersicht der häufigsten, nach Ursprung gruppierten Mängel wird gegeben.

Schlüsselwörter:

Wohnversorgung, Gebäudebau, Wohnungsstruktur, Wohnungspreisstruktur, architektonischen Ausdrucks

1. Introduction

The topic of influence and importance of architectural aspects was elaborated within the *Housing Care Programme for Croatian Homeland War Victims*, which is a large scale programme covering a wide area. The principal features of the Programme are described, its properties and goals are presented, and an overview of typical architectural features in the design and implementation is presented. It is necessary to correctly evaluate the buildings to determine whether they are capable of fulfilling the inhabitants' needs, as specified in the Programme, [1]. Due to the fact that the programme and the management procedures used are standardized, it is possible to evaluate the results in a way that will improve the design and construction standards.

The *Housing Care Programme for Croatian Homeland War Victims* was established in accordance with provisions of the Act on the Rights of Croatian Homeland War Veterans and their Family Members (OG 108/96), [2] and it consists of six programmatic parts, [3], which differ depending on the requirements and modes of implementation. The analysis conducted is based on the results of the *Programme 4*, which is the most complex programme in all aspects that are usually evaluated in the preparation and management of a project, [4]. Other programmes are not evaluated in this overview, as they deal with acquisition of finished or almost finished units (*Programme 1*), construction of family homes for disabled veterans with the 100 percent disability, and for persons with reduced mobility (*Programme 2*), finishing of residential units that were not designed and built according to the programmatic guidelines issued by the Croatian Ministry of Defence (*Programme 3*), loans (*Programme 5*) and reconstruction of houses destroyed in war (*Programme 6*). Requirements were defined within the implementation of the *Programme 4*, which was divided into four different models, and, once an appropriate model was selected, the competition brief with the complete set of requirements for buildings on a specific site was defined. The differences between these models are in diverse relations between the investors, architects and contractors, depending on site characteristics. Models are named *Model 4.1.*, *Model 4.2.*, *Model 4.3.* and *Model 4.4.* and are briefly described as follows:

Model 4.1.

In this model, the design and construction works are contracted during the tendering process, with a single contractor, as a turnkey project where the price per square meter of useful floor area is agreed upon in advance. The Ministry of Public Works, Reconstruction, and Construction, successor to the Ministry of Development and Reconstruction, today the Ministry of Construction and Physical Planning (later referred to as the Ministry, MCPP), organized the bidding for the design and construction of residential buildings with a predetermined housing unit layout, situated on building lots provided by local authorities. According to this model, the contractor offered complete design, issuance of all the required permits, and building construction. The model is fast and time efficient, and

the contractor and designer continuously check that the works are performed on schedule, and that the design is tailored to the technology used by the contractor.

Model 4.2.

Design is contracted separately and, after delivery of design documents, the construction work is contracted through tendering for the turnkey phase with the agreed price per square meter of useful floor area. This model is used in case of very complex urban settings, specific foundation requirements, etc., or in case of longer preparatory periods due to longer time available to implement the programme. For reason of ubiquitous time limitations, it was not possible to organize a competition for all sites, and so in May 1997 the Ministry organized, in cooperation with the Croatian Architects Association, a nation-wide, public, one-stage, anonymous competition for the prequalification of architects, or architecture offices, for elaboration of the design and technical documents for construction of housing units based on the model principle. The competition was launched following two preset standards: continental and Mediterranean type with two competition briefs – one for apartment buildings with 6 to 10 units, and another for 20 to 26 units, [5].

Model 4.3.

Acquisition of existing apartments in cities where local authorities did not provide building plot, also in turnkey phase, with the agreed price per square meter of useful floor area. If the chosen contractor was only in the beginning phase of the construction of the apartments, project documents for such dwellings underwent complete monitoring procedure. The aim of this procedure is to make sure that the acquired apartments are designed according to specific requirements set by the Ministry, as in Models 4.1 and 4.2.

Model 4.4.

Contracting of construction work following the unit cost system was used for certain sites where the apartments for Homeland War victims were provided through reconstruction or adaptation of existing apartment buildings. Based on the full design documents with detailed cost estimate of planned construction works, contractors submit tenders for reconstruction of apartments in existing buildings. This model of contracting has been rarely used, and the need for specific reconstruction works made apartments from this model the most expensive per square meter of useful floor area.

Guidelines for the Design of Apartment Buildings for the Homeland War Victims, [6], formed an integral part of the competition files. Two editions of these *Guidelines* were published during the Programme implementation, in full accordance with the 2005 *Building Code*, [7]. The second edition of *Guidelines* was actually a revised edition, based on the experience of particular users, i.e. the family structure that resulted from the war and post-war circumstances, [8]. The data from *The Sociological*

Evaluation of Flats of Victims of the Patriotic Defence War, which is a research project conducted by the Ivo Pilar Institute of Social Sciences and the Zagreb Faculty of Architecture, were used in the preparation of *The Second Revised Edition of the Guidelines*, published in 2000, [9]. After eight years of programme implementation, the 2005 Building Code, [7] significantly simplified and abbreviated the *Guidelines*. They were reduced to an easily applicable form, while keeping instructions relevant for the architects, so that the Programme can be implemented under the same conditions ensuring an unchanged level of quality of finished apartments. Due to a reduced number of new apartment buildings, the Programme management was modified by eliminating consulting support on both general and regional levels.

A set of precisely defined criteria for evaluation of elements specified in the tender documentation was used in the evaluation of proposals made within the public procurement procedure. In case of significant discrepancy between the cost and architectural value of the design, the investor reserved the right to select the lowest-cost proposal, provided that a new design is made by another architect chosen through a public tendering process. This system of contracting by choosing the lowest bidder was made possible by the turnkey provision and use of a standard cost estimate combined with the architectural design. In that phase, the design could easily be replaced with another one, according to investor's wishes, provided that it complies with the compulsory *Guidelines*. To secure quality of design documents and their compliance with both *Guidelines* and the specifics of particular sites, the preparation of design documents underwent continuous monitoring and corrections by an architect auditor. The auditor's task was to guide the designer in harmonizing the design documents with the requirements, as the architectural design proposed by the chosen bidder served just as a basis for further elaboration of design documents. Compliance with design documents was monitored according to the design-documents monitoring methodology, adopted by the Ministry as part of the *Design Documents Production Protocol*. Reviewing of design documents enables the investor to completely meet the programme requirements for housing construction [10]. The mentioned architects were selected in the bidding process for pre-qualification of architects, after evaluation of the design, functional and technical proposals, and specific technical settings defined in the brief, [11].

The data from the auditing procedures demonstrate that, between 1997 and 2003, four regional consulting companies, in addition to the umbrella consultant, participated in the Programmes that are the subject of this overview. One to four auditors operated under the umbrella consulting company, and regional consultants employed 1-2 auditors, depending on the number of projects. During the Programme implementation, an overall number of auditors varied in different stages. The oscillation in their number and frequency leads to the conclusion that it is difficult to successfully coordinate all stakeholders within the management system and risk management system, i.e. to achieve an ideal level of quality of auditor expertise,

regardless of the fact that parameters of their tasks are clearly defined.

2. Implementation of the Housing Care Programme for Croatian Homeland War victims

After 15 years of the Programme implementation, from 1997 to 2013, its positive and negative features can adequately be classified. After 2001, the Programme was partly modified, as the practice of binding architects to construction companies was abandoned. The major part of the Programme was initially started in accordance with the defined project investor/construction follow up, with the cooperation of a number of institutions and experts, independently from the laws and regulations then in force, which stipulated monitoring and evaluation of projects regarding issuance of necessary approvals and permits.

By the end of 2012, 5.542 apartments on 240 sites were handed to users within the framework of the *Programme 4*. Out of that number, 3.957 apartments on 101 sites can be classified in the group of apartments designed and built following the described method by the year 2003. Besides that, 313 apartments in 101 sites were acquired by the end of 2003, [12]. This number provides a referential quantity for the analysis and evaluation of buildings designed and built according to that model, all according to predefined conditions and in the period exceeding 10 years. Another 87 apartments were completed in 2013.

Diagram 1. displays construction and acquisition of apartments within the Housing Care Programme for Homeland War Victims, according to the year of handover.

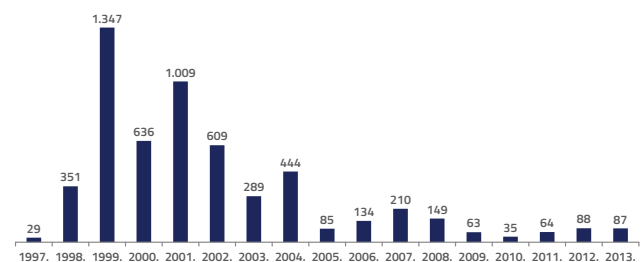


Figure 1. Diagram of apartments according to year of handover, Source: MCPP, [5]

2.1. Classification of housing units

The overall number of apartments built within the *Housing Care Programme for Croatian Homeland War Victims* can be divided into four referential periods. Period 1 relates to dwelling construction from the beginning of the Programme managed by the Ministry of Defence, after which came the Period 2 from 1998 to 2000 when apartment buildings were designed according to the *Guidelines for Design of apartment Buildings for Homeland War Victims*. During the Period 3 from 2001 to 2005 buildings were designed according to the second revised edition of the Guidelines. The Period 4 began after publishing of the Building Code in the September of 2005.

Table 1. Number of dwellings according to referential periods and demands expressed by Ministry of Veterans' Affairs

PERIOD [year]	NUMBER OF DWELLINGS
I. 1997.	1028
II. 1998.-2000.	2092
III. 2001.-2005.	515
IV. 2006.-2012.	215

According to the requirements, i.e. the number of family members as reported by the Ministry of Veterans' Affairs, the government concluded contracts on the design of apartment buildings, or acquired existing apartments of adequate size. Table 1 shows the number of designed or acquired apartments in the four referential periods when the area and number of rooms were determined in accordance with applicable Guidelines for the design and construction.

Out of the total number of 5.542 dwellings handed over by the end of 2012, the data for 3.850 dwellings with the total

area of 236.940,93 square meters were processed which represents 69,5 % of the housing stock. Based on the data from the competent ministry, two diagrams, Diagram 1 and Diagram 2, represent apartments classified by layout and surface area during the four referential periods.

In the first group (from the beginning of the Programme implementation), due to particular needs of the users, almost one half (48 %) of the built apartments were small apartments (studios/GS, one room apartments/1S, one and half room apartments/1,5S) while medium-sized apartments (two room apartments/2S, two and half room apartments/2,5S, three room apartments/3S) were less common (41 %). The quantity of large apartments (three and half room apartments/3,5S, four room apartments/4S, four and half room apartments/4,5S, five room apartments/5S) was rather small in the beginning (11 %) compared to the other groups. When the programme entered a stable period, and after a large number of single people (for example war victims' widows) and childless families were given apartments, more than one half (63 %) of apartments built from 2006 to the end of 2012 were two room, two and a half room and three room apartments, i.e. 22 % more

than in the first period, while the quota of smaller (GS; 1S; 1,5S) dropped by 12 %. The quota of larger apartments (3,5S; 4S; 4,5S; 5S) became very small in comparison to the total number of apartments. This distribution of apartments according to size can be useful for planning future apartment building construction, without a defined user.

After 2006, the structure of apartments according to the number of rooms within the *Housing Care Programme for Croatian Homeland War Victims* became constant until the end of 2011. Diagram 4 shows changes in contingent depending on the year of design, based on data obtained from the competent ministry. The average surface area of all newly built apartments is constant throughout the Programme, i.e. it varies from 55,72 to 68,79 square meters, the difference being 13 sq. m according to the year of design (see Diagram 5). The first edition of *Guidelines* stipulated that studio apartments measure 35 sq. m, one room apartments 45 sq. m, two room apartments 60 sq. m, and two-and-half room apartments 70 sq. m. The 2000 Guidelines added three-and-half room apartments of 80 sq. m floor area and four room apartments of 90 sq. m, while the last edition of Guidelines from 2005 added the one-and-half room apartments of 50 sq. m, three room apartments of 80 sq. m, and four-and-half room apartments with

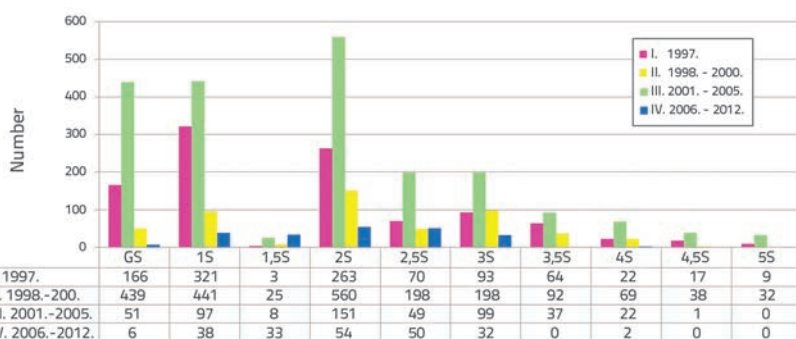


Figure 2. Structure of housing units according number of rooms and year of design within Housing care programme for Croatian Homeland War Victims, Source: MCPP, [5]

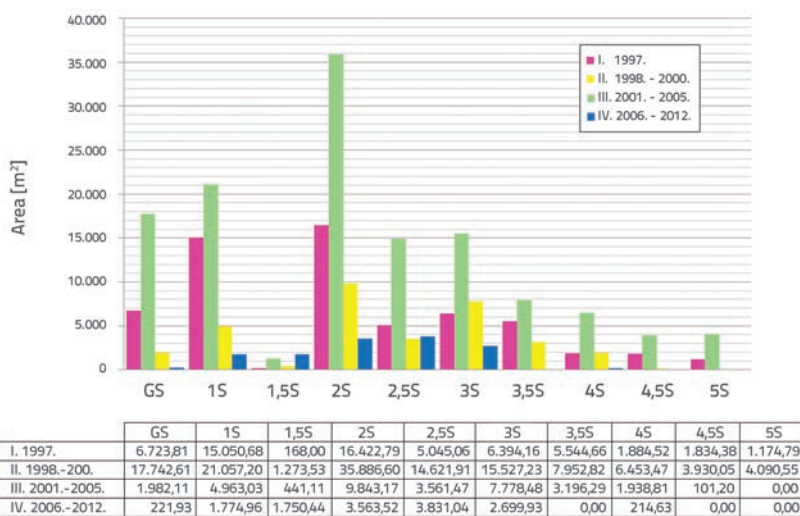


Figure 3. Structure of housing units according to the area and year of design within Housing Care Programme for Croatian Homeland War Victims, Source: MCPP, [5]

100 sq. m in floor area. Studio apartments consisted of one room, one and one-and-half room dwellings had two rooms, two and two-and-half room dwellings consisted of three rooms, three and four room dwellings consisted of four rooms, and four-and-half room dwelling had five rooms.

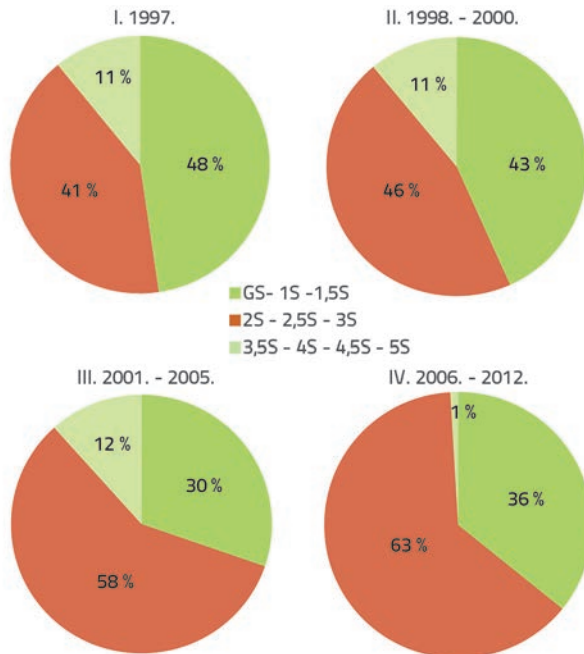


Figure 4. Change in structure of housing units within Housing Care Programme for Croatian Homeland War Victims according to year of design, Source: MCPP, [5]

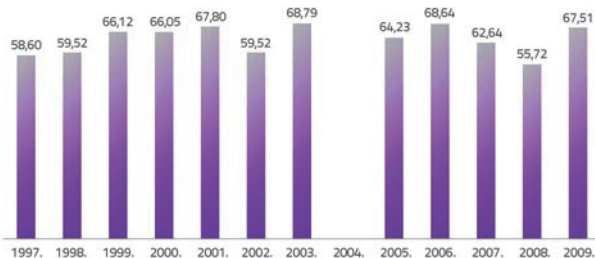


Figure 5. Average useful floor area depending on year of design, (sqm), Source CBS, [13, 14]

Diagram 6 is based on the data provided by the Croatian Bureau of Statistics (CBS), covering the period from 1997 to 2012, [13, 14], as well as on the data from the competent ministry. It displays the number of rooms of the completed dwellings for permanent residence built in the observed period and apartments built within the *Housing Care Programme for Croatian Homeland War Victims*. The guidelines for the design and construction of apartments within the Programme stipulated the design of studio apartments, one-and-half room apartments, two-and-half room apartments, three-and-half room apartments, and four-and-half room apartments, which were not described in the Croatian Bureau of Statistics data on categories of permanent residence

dwellings. The classification of dwellings shown in Diagram 6 is derived by applying the Croatian Bureau of Statistics' definition of dwellings regarding the number of rooms to the dwellings within the Programme. Two different dwelling classifications show a disproportion, especially in the case of larger dwellings. This could be one of the reasons why a significant number of apartments has remained unsold.

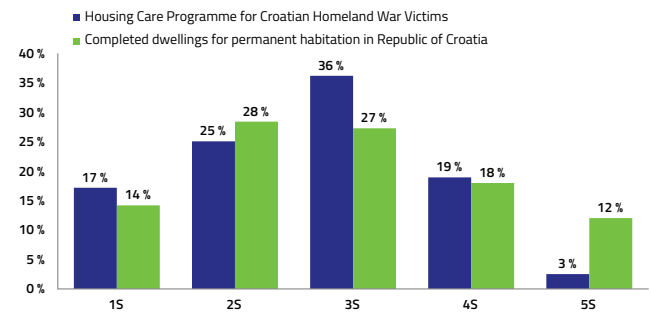


Figure 6. Structure of housing stock within the Housing Care Programme for Croatian Homeland War Victims (blue) and Completed dwellings for permanent habitation in Republic of Croatia (green), according to number of rooms, between the years 1997 and 2012, sources: CBS, [15], MCPP, [5]

Between the years 1997 and 2003, the average price of apartments within the Programme amounted to HRK 6.391 per sq. m, while in the period from 2004 to 2011 it was HRK 7.489, which amounts to an average of HRK 6.997 per sq. m during the entire period, [5]. At the same time, according to the data obtained from the Croatian Bureau of Statistics, the average price of new dwellings not included in the POS programme (dwellings built following the Act on Socially-Supported Housing Construction) amounted to HRK 10.155 per sq. m, while the price of POS dwellings was HRK 6.592 per square meter [15]. The standard price was HRK 3.400 from 1 June 1995 until the first significant change on 2 January 2002 (HRK 5175), and it stabilised at HRK 5.808 since 30 April 2008. Therefore, the average amounted to HRK 4.788 per sq. m.

When discussing the price, it is necessary to explain the quality level of construction and craft works, as well as the quality level of built-in equipment in relation to declared prices. Since the construction cost was agreed upon for the useful floor area of finished dwellings (turnkey), the cost estimate was prepared for all works that could occur within the construction process. It had to comply with the Guidelines regarding the quality of construction, crafts works and built-in equipment. The contractors were obliged to define all standard cost estimate items used in their design proposal. Thus, the pre-tender estimate became one of the most important documents in the realisation phase, as there was no measurement book in the construction process. The pre-tender estimate defined a new construction standard, materials to be used and level of equipment in both the dwellings and in the entire building. For that reason, during the design process monitoring and definition of the final design, the consulting service in cooperation with the chosen contractor

simultaneously updated the contract to prevent raising issues on the estimated works, or the quality of construction. The quality and level of the finished building were planned to match the quality of an average housing unit offered on the market at the time. The Programme was implemented in full accordance with prevailing regulations, to make sure that the minimum quality standards for construction and equipment are being met. For example, it was stipulated that windows have to be made of the first class spruce or fir wood (67x78 mm window frame), and insulated glazing (or float glass), with a coat of scumble paint or varnish, using a wet or dry installation process. Modular dimensions were also prescribed, and so were the options for plastic or aluminium windows and doors, and for the types of shades and louvres. Rules for all construction elements were defined in the same manner.

The dwelling unit price structure applied in the Programme was defined following the same logic, with 92 % of the overall price for the construction costs, and 8 % for the design, supervision, consulting and other preparation and management costs. This is shown in the Diagram 7. In accordance with the Act on the Rights of Croatian Homeland War Veterans and their Family Members (OG 108/96), the local government was obliged to provide building plot, and so its price was not included in the overall cost, [2].

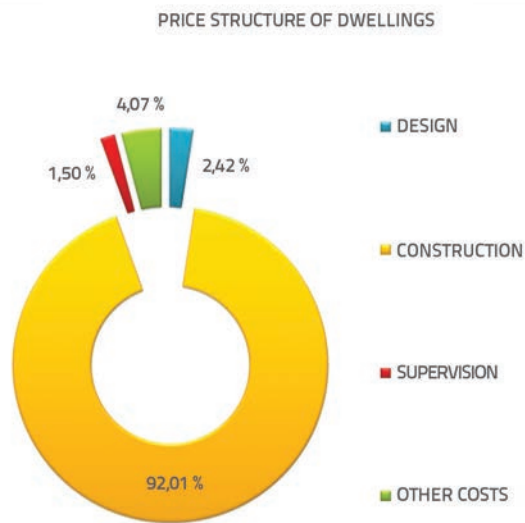


Figure 7. Price structure of dwellings built within Housing Care Programme for Croatian Homeland War Victims excluding costs of building plot for the period 2004- 2011, Source: MCPP, [5]



Figure 8. The office-residential building in Vukovar, by Vinko Penezić and Krešimir Rogina, Source: Vinko Penezić and Krešimir Rogina, Architects' Archive



Figure 9. The office residential building in Vukovar, Main floor layout, by Vinko Penezić and Krešimir Rogina, Source: Vinko Penezić and Krešimir Rogina, Architects' Archive

2.2. Quality of architectural design

The resulting architecture is to be judged according to both quantitative and visual aspects. Buildings that were designed and executed within the Programme cannot be sorted under a common denominator be it according to the quality of design, quality of applied technical details or, finally, according to requirements for a good and comfortable living space. Since various architects interpreted and applied mandatory Guidelines differently, the results also differed from what was generally expected.

By applying reviewing mechanisms throughout the design phase, the investor managed to eliminate concepts that have already been recognized as possible source of risk for the quality of design and its implications on the value of housing throughout the life span, [16]. Three successful examples where the Guidelines have been fully applied confirm that within controlled, financially restrictive, and strictly defined rules, the designers can produce good architecture, and receive approval from their peers. The office-residential building in Vukovar, designed by architects Vinko Penezić and Krešimir Rogina, received the "Vladimir Nazor" Award for the best accomplishment in the field of architecture and town planning in 2001. The jury stated "Its disciplined and simple layout follows the footsteps of best achievements of the Croatian modern architecture and its exquisite results in social housing. The design is consistent with its commitment to modern expression being both restrained



Figure 10. Apartment building B in Rijeka, by Goran Rako, Source: Goran Rako, Architects Archives



Figure 11. Apartment building B in Rijeka, Main floor layout, by Goran Rako, Source: Goran Rako, Architects Archives



Figure 12. Apartment building Borovje K5-1B in Zagreb, by Danijel Marasović, Source: MCPP, Photo Archive, [5]



Figure 13. Apartment building Borovje K5-1B in Zagreb, Ground floor layout, by Danijel Marasović, Source: Programs and Models with Catalogue of Designs, [11]

and adjusted to its surroundings', [17]. The building is interpolated in the urban tissue on the bank of the Danube, about a recently renovated three-storied house. The design of commercial and residential areas visually demonstrates their differing functions. The south-facing gallery on the residential section adds to the quality of living by providing natural light and ventilation to small dwellings. Mindful proceeding from public area to the private one, using simultaneously light and texture, plus symmetry and strict design of both layout and front, adds value and provides excellence to this building. Although way beyond average in terms of architectural quality, not only within the Programme, its price did not differ greatly from the default value.

In the ensuing year, Goran Rako received the yearly award "Viktor Kovačić" for the Apartment building B in Rijeka, for the best architectural accomplishment in general. The Croatian Architects Association Advisory Board states: *It fulfils every necessary requirement for an apartment house: good layout, good position on the building lot, good typology, and good design. A further element influenced the decision of the Jury: the gallery*, [17]. This building also makes use of the gallery in an appropriate and justified manner. On the west-side, it protects adequately from the wind and rain, making possible two-sided orientation of dwellings and good natural ventilation. Recessing the gallery below the level of entrance to dwellings provides an additional quality and privacy to the dwelling.

However, the very aspect that enhanced architectural design led to remarkable difficulties in other aspects and so, for instance, the gallery was sometimes misplaced with regard to the position of the building within the lot, orientation of the building was miscalculated, or specific weather conditions of the site were not taken into account.

Within the Programme, some 50 % of layouts featured four dwellings per staircase, and a very small number had five or more. The successfully completed design by Danijel Marasović for the apartment building in Borovje in Zagreb is

an exception. Vertical communication is reduced to one centrally situated staircase area out of which two central corridors lead to four and five dwelling units each. The resulting orientation of dwellings toward one side only is mitigated by positioning the building east- and westward, thus ensuring adequate insolation to all dwelling units.

The Programme is conceived to unify complex and time-limited housing construction regardless of how the contracts for the design and construction were agreed upon. As this is primarily a multiple-dwelling construction, there are almost no pavilion-like developments or terraced housing units that would otherwise be adequate and acceptable for this Programme. This is on the one hand due to planning requirements and on the other to the fact that construction lots presented by local administration did not allow for any other kind of development. At the same time, the investor paid special attention to architectural types that allow for an energy-efficient construction.

The idea to upgrade housing in general and to assign this role to the architect brought in the end some excellent results, but sometimes it also resulted in concepts that, in the life span of the buildings, brought about problems and ravaged both the structure and the ambiance. This happened whenever the users "intervened" either on their private dwelling units or on public (common) parts of the building, thus creating, within this and other frameworks and projects, a distorted image of humane housing, [18].

2.3. Amendments to the Guidelines

After analysing the *Guidelines'* implementation, amendments were made to the first edition in order to precisely define standards for individual dwellings and apartment buildings, and to satisfy requirements of both individual users and investors, allowing the investor to monitor the design and construction processes. One of first amendments (1998) attempts to raise the standard by:

- providing larger apertures on the front to allow subsequent remodelling of a larger room to obtain two smaller ones,
- adding a minimum 8 sq. m room to the basic content for smaller dwellings (2,5 room dwellings),
- permitting design of kitchen area within the living room,
- based on investors' experience, permitting design of semi-closed galleries that provide shelter from wind, rain and snow,
- designing and constructing ramps to enable access to people with special needs to the main entrance level,
- designing elevators for all buildings having four storeys above ground floor (P+4) if they have more than 24 dwelling units, [5].

The *Guidelines* were further amended in the second edition issued in 2000. The amendments were based on the investor's experience in organizing and implementing the

second investment cycle from 1997 to 2000, with regard to both technical and social aspects [19].

3. Problems connected with structures requiring repairs

1.449 dwellings were completed by the start of the year 2000 (a total of 2.508 were in various phases of completion – ranging from preparatory phase to full completion). Besides several exceptions (problems arising between the investor and the contractor leading to shutdown of construction process and its subsequent activation), these units were completed and the residents moved in by the end of 2003. All buildings were in use for a period ranging from 8 to 13 years, and were monitored throughout this time, within and after the two-year defects-liability period. The monitoring activity focused both on the specific profile of design, and on the use value for the end user. A series of problems in direct or indirect relation to architectural design and to the required design and implementation procedures were identified.

The total of 26 apartment buildings underwent rehabilitation in the period from 2004 till 2011. Identified flaws made proper use of the dwellings units and common areas somewhat difficult. 976 dwellings within the buildings that underwent rehabilitation amount to one quarter of all dwellings developed within the Programme. Causes of damages can be divided into three following groups:

- A) formed during design period,
- B) formed during construction, and
- C) formed during usage.

The following analysis refers to flaws from the preparatory/design phase of the project, which resulted, during construction and utilization, in the damage that required further investment to make living in such buildings possible, [20]. The flaws can be divided into the following groups that generate specific problems:

- (A1) not taking into account local climate conditions and specific features of the area;
- (A2) not respecting local architectural features and specificities for certain areas, and not applying typical ambient elements,
- (A3) designer is not sufficiently skilful in applying new technologies and new construction materials,
- (A4) inadequate construction details due to lack of expertise and experience of the designer,
- (B1) bad work due to digression from original design and/or uncoordinated design documents,
- (B2) using building materials of quality that is lower than planned,
- (B3) deficient blueprints on the construction site to adequately monitor building operations, or working with no blueprints at all, [21],

(C1) inadequate dwelling unit remodelling by users,
 (C2) repair of damage after the building is handed over to the investor.

(A1) Damage and defects to the building are dominantly due to the design that does not take into account local weather conditions such as the wind and snow loads, precipitations, low temperature, and long intervals of exposure to extreme heat (freezing and de-freezing) exceeding the average, affecting most often:

- protrusions,
- balconies,
- terraces and loggias,
- galleries,
- large glass panels,
- sliding sunscreen panels (frequent flaws in areas with dominant wind load),
- protection of apertures (shutters, blinds, jalousies, louvres).

The majority of listed climate factors, as well as an incorrect design of protective elements, are linked to moisture leaks into the building and dwelling units.

(A2) Renouncing and neglecting typical local elements when shaping the outer shell of the building like:

- saddleback roofing,
- gables,
- airscoops,

resulted in frequent leakage and moisture in the building.

(A3) Lack of knowledge when selecting the building system and application of inadequate details for new technologies like:

- Ytong system – details of joints of apertures, parapets, lintels, horizontal and vertical ring beams,
- preparation of the system elements as a basis for application of other materials – reinforcing mesh plus application of finishing layer, etc.,



Figure 14. Faulty gallery design, Source: MCPP, [5]

- inappropriate choice of technology; for instance, using thermal plaster instead of ETICS system, resulting in heat bridges on ring beams, lintels and columns that are not adequately insulated,
- inappropriate realization of installations on external Ytong walls.

A4) Details as functional parts of building context presented a special problem:

- heat bridges,
- waterproofing joints,
- installation of window sills depending on construction material,
- use of inadequate building material for specific details,
- inappropriate contacts between different materials,
- inappropriate flashing finish at the contact with the basic material,
- tightening groove connection and breaches through structural elements, etc.

(B1) Due to insufficient engagement of architects, lack of supervision, and lack of opportunity for the architect to verify changes in plans, poor compliance was noted between the utilities' plans and the building plan:

- position of ventilation ducts,
- position of fittings (radiators, water heaters, bathroom equipment),
- position of sockets, switches, various outlets etc.

(B2) Using building materials not corresponding (by type or quality) to those specified in the design, without control and approval by the designer, leading to visual and qualitative devastation of the design.

(B3) To enable adequate monitoring, the design documentation must be delivered on time and should include all necessary details, since the delayed delivery of designs leads to mistakes in planning and subsequently in poor realization of work.

(C1) After takeover of the building, all modifications made by end users in individual dwellings or on the building (like repair of walls, tiles, parquet, insulation improvements, etc.) were monitored by the Ministry of Veterans' Affairs. A detailed evaluation of aspects regarding usability and damage resulting from interventions by dwellers was done by Ivo Pilar Institute together with Faculty of Architecture, [9, 22].

(C2) Flaws resulting from mistakes during the construction phase appeared in the course of use of the buildings. They were usually reported during warranty period and were subsequently repaired. In 26 out of 240 apartment buildings flaws that could not fit into provisions of warranty were remedied. An average value of repair amounted to 10,9 % of investment value of each of these buildings. On the

entire Project level, repairs amounted to 1,97 % of the total investment value.

In the majority of cases several simultaneous events, related to both design and incompetent building process, caused damage during use of the building, water being the most frequent cause of destruction. By respecting basic design rules regarding water, like shaping geometry of surfaces so that water can flow away using the shortest possible route, by inhibiting water to pervade the structure, by dealing correctly with sewage and making sure that structural elements are watertight, the majority of impairments could have been avoided.

Some designs from the very beginning of the Programme demonstrate that the quoted drawbacks can easily be avoided if the designer and the contractor establish proper cooperation from the earliest stage of design. Such collaboration can result in design that is technologically harmonized with the contractor's capabilities, [23].

4. Conclusion

The configuration and implementation of the Programme following the previously established method with precise instructions for architects, and monitoring the use of each building, provided the basis for the analysis and the groundwork for drafting a standardized method for following the architects' work and the problems faced by the investors and building users. The concept that the contractor, rather than the architect, controls selection of the construction method did not bring expected results. Despite an additional control provided by the investor's supervision, and the constant supervision on the construction site, errors occurred due to short deadlines and the lack of architects' supervision of the construction process. Deficiencies also resulted from low construction costs and incomplete design documents delivered to the site in fragments, due to the fact that the time for design work was too short. The introduction of auditors and monitoring of design document preparation according to the established method did not entirely solve the quality issues, as the auditors had tight deadlines and were not authorized to reject the design. They could only instruct the architect to make the necessary corrections instead.

The Croatian Chamber of Architects and Engineers was founded in 1998 and, by the end of 2000, the first insurance contracts covering damage to third parties were concluded. Taking into account that 2.359 dwellings were built and handed over by then, the additional costs could not be reimbursed by insurance which would have diminished the damage. Furthermore, the construction works were performed according to the architectural design, without the detailed construction design, which affected the quality and accuracy of construction work. Additional problems arose from the obligation to select the lowest bidder in the public procurement process, since the model based on the standardized cost estimate and turnkey construction with the fixed final cost, and with the added possibility to improve or request new design, did not provide better quality of construction. It seems that the observed design practice, despite the standardized procedure, did not take into account the design methods imposed by specific site characteristics, and suffered from lack of competence with regard to application of new construction technologies.

Therefore, it is necessary to continuously educate all participants in the construction process, especially as since 1 January 2014 the lifelong education is no longer obligatory, but optional, as stipulated in the Building act (OG 153/2013), [24]. Simultaneously with the implementation of the programme, numerous construction companies have encountered financial hardships that originated before or during construction, and additional losses occurred despite insurance mechanisms contained in the contract. Interruption of construction works and contract termination, success of damage recovery on site, and resumed construction with a new company, resulted in new problems and an increase in overall building costs. The Programme was established to produce a large number of new homes in a short period of time, and regardless of its perceived shortcomings, it has set a standard that enabled further improvements through development of new housing programmes funded by the federal and local governments. Looking back at the Programme, it is obvious that this topic has further research potential in specific segments and, in this respect, some of possible future research topics are proposed in this conclusion.

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