Reviews

UDK 697.514
doi: 10.7251/COMEN1302137I

NATIONAL BUILDING TYPOLOGY AS A SOURCE FOR AN ADEQUATE REHABILITATION POLICY

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Abstract: Serbia's Law on Planning and Building has imposed the topics of energy efficiency in building sector, requiring adequate policy making and providing a starting point for improvement of the current situation in this field. Considering the fact that there are more than 3.200.000 housing units without any statistical classification a need arose for establishing a national building typology as a starting point for further decision making and appropriate activities definition regarding the existing housing stock.

After joining EU TABULA (Typology Approach for Building Stock Energy Assessment) project, methodologies and approaches of the European countries have been analysed providing a common experience, at the same illustrating a need for identification and classification of local characteristics. In order to obtain adequate data a comprehensive survey has been conducted, providing a starting point for creation of typology. The National Typology has identified typical "model" buildings and defined the levels of improvement ranging from standard (according to the current law) to the low-energy level. The paper explains the methodology, procedures and local characteristics of the process and gives an insight in the activity describing the problems and potentials of the approach.

Keywords: residential buildings, typology, energy efficiency, regulations.

1. INTRODUCTION

Following the current trends of energy efficiency but with a significant delay compared to the other European countries, Serbia has defined the basis for structuring this field in the building sector by enacting a new Law on Planning and Construction in 2009. A concept of energy efficiency of buildings has been defined in a single article and a need for building Energy Performance Certificates (EPC) issuance declared. In the period to follow, a set of by-laws was developed in order to facilitate the procedure, starting from September 2012. EPCs are included as a part of obligatory construction documentation necessary to obtain the building permit for new constructions and major renovations. Energy performance of buildings is certified through the calculation of level of annual energy used for heating per square meter of floor area and explained in the form of primary energy and CO_2 emission. This procedure, fully compliant with the European regulations, departs from the current Serbian practice and regulations imposing much stricter requirements for thermal protection of buildings. More importantly, it also changes the design approach from thermal performance of building envelope to total building performance taking into account all losses and gains, annually. The regulations have provided a framework for design but the impact that the implementation will have especially in the field of existing buildings treatment is largely unknown. Construction activity, due to the current economic situation in Serbia has dramatically decreased with less than 1% [4] of new buildings being constructed annually, thus shifting the interest of energy efficiency towards the treatment of the existing building stock. The experts realized that a comprehensive survey of building stock had to be performed in order to define a starting point for the evaluation of the potential of energy savings through the process of rehabilitation. Research has focused on residential building typology.

2. DEVELOPING THE METHODOLOGY

Structuring the building stock and definition of the relevant typology is mainly influenced by the availability of relevant data. The most accurate data could be derived from the National Census, which is

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carried out in Serbia every ten years. The methodology of Census defined in the 1950s has been improved but does not reflect a full spectrum of information needed for the analysis of the building stock. The last census was conducted in the autumn of 2011 and was based on several questionnaires partly covering the building characteristics. Questions were organized in two ways: those to be answered only by the tenants usually giving information about the structure of residential units: the construction year of the apartment (building), the area of the apartment, number of rooms, installation status (types of installation provided: electricity, plumbing, sewage systems), fuel used for heating, and the questions dealing with the building category and partly assessed by the enumerator: type of the building (free standing single family house, free standing duplex house, semi-detached house, terraced house with at least three attached residences each with its own entrance, multi-family house with 3-9 apartments, apartment block with 10 or more apartments) and external wall material (rigid or soft). This is actually the first time that any information dealing with the urban characteristics of the buildings has been collected at the national level.

The collected information can be very useful, (although full availability of the data for the public is planned for December 2012); it however does not facilitate the assessment of the quality of energy performance of buildings nor does it provide necessary information for defining rehabilitation strategies leading towards the evaluation of national energy savings potential. A decision was therefore made to undertake an independent survey for the purpose of this research, based on a statistically relevant sample, to enable the creation of national residential building typology based on which the energy performance of building stock can be assessed. The experts realized that this activity would have to try to structure and evaluate all specific architectural and urban parameters in design and construction reflecting the local characteristics of Serbia.

As a starting point, the methodology followed the model adopted within the IEE Project TABULA [5], using the information gathered in the previous DATAMINE project, but with the specifics of Serbia. The European approach largely depends on the information that can be retrieved from the EPCs being issued according to the national procedures and by various local or national databases and registries of buildings, a method which is not applicable in the Serbian case. For this reason we had to design a procedure of data collection which will enable us, based on the EU partners' experience, to create a national typology.

2.1. Serbian Specifics

Like many other European countries Serbia suffered massive devastation during World War II, especially of urban areas. A change of political system that followed marked by the Socialist policy of development and planned economy tried to change the structure of the country and the cities, by forcing urbanization as a symbol of modernity and progress. This meant that there were very few large-scale reconstruction processes in the urban areas; instead, the development of "new" cities took place. Large migrations to urban areas were encouraged requiring sufficient supply of apartments. This production was carried through mainly by developing new suburbs consisting of multi storey buildings often constructed by state-owned, mega companies, that used the technology of recognizable prefabrication systems. These "dormitories" had a uniform architectural style, construction and material characteristics and were often marked by residential towers with more than 150 units. Slowing the socialist economy and gradual change towards the market orientated economy reflected in the construction process, mainly by orienting it towards a smaller-scale construction and interventions in the existing urban tissue of "old towns".

Over time, individual initiative was not banned but it was not regulated either and was usually carried out by erection of single-family houses, located mainly in rural areas and on the outskirts of the cities. This meant that the settlements of this kind were not covered by planning regulations and buildings were usually constructed without building permits, therefore very few regulations were followed. This trend was largely increased in 1990s, following the breakup of Yugoslavia, as a big number of refugees came to Serbia, mainly to urban areas, who had to rely on non-institutional solution for their housing needs. As a result of such housing policies uneven and very often non-controlled development was present with constant decline of rural settlements and population and a great increase of urban ones with occasional high residential densities recorded.

In order to analyse such a diverse building stock, a set of starting parameters were defined covering several areas affecting the typology:

Architectural and planning parameters

The classification based on these aspects included eight types of buildings and was developed according to the following postulates [3]:

- The relationship between the building and its lot with special emphasis on the socialist period housing projects. This period is characterized by large-scale construction in "open" blocks with unified, usually identical buildings.
- The location of the building with respect to the neighbouring structures.
- Classification according to the number of apartments: one family, multifamily (up to 4) and collective dwellings. As a separate type, high rise residential towers were identified.

This classification (Fig. 1) was done having in mind thermal properties of the buildings as well as possibilities for rehabilitation and represents a new approach for Serbia.

Figure 1. Classification scheme: building types for single-family and collective dwelling

Parameters influencing thermal performance of envelope

The parameters analysed cover several aspects of building form, structure and appearance and were set according to the following premises (Fig. 2):

- Shape of the building explained by the ratio between the envelope and the corresponding volume resulting in three categories: compact, elongated, non-compact.
- Quantification of "openings" on the envelope illustrating the relationship between the number and types of windows and facade face, appearing in three categories: small percentage of individual openings (less than 50% of the facade), high percentage (more than 50%) and window frames (typical appearance of the construction in 1960s and 1970s)
- Using of attic and basement spaces that defined the existence of such a space and the way it has been used.

Construction year class

The construction period does not directly influence the performance or classification but provides cross referencing towards significant regulations and construction techniques applied. In particular, classification has been characterized by:

- The introduction of thermal regulations (estimated time of applying certain regulations is approx. 2 years which represents an average design to construction period in Serbia)
- Socio – political events:
  - World Wars I and II, especially the period from 1945-70 that was characterized as the most

dynamic and fruitful changing the face of the country.

o Transforming the economic system and the breakup of Yugoslavia in early 1990s meant that the state-controlled construction process was not in force and that the whole construction activity shifted towards the individual initiative.

• Changing the planning doctrine from large-scale development (mass construction) to single building construction followed by reaffirmation of traditional city matrix.

The chosen periods were therefore chosen as: before 1919, 1919-1945, 1946-1960, 1961-1970, 1971-1980, 1981-1990 and 1990-present.

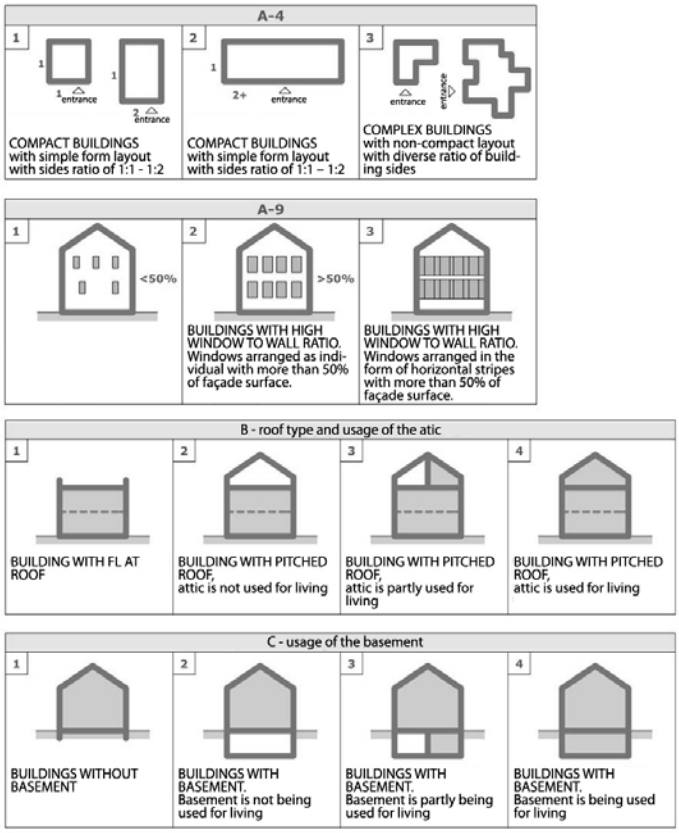

Figure 2. Classification scheme: building geometry type, percentage of openings, usage of loft and basement

2.2. A statistical sample

All these analyses have to be applied on a specific statistically relevant sample in order to gather the data for further analysis and estimations. As mentioned above, an independent survey by a third party professional firm has been conducted. In the design phase of the process it was decided, due to the limited financial resources that a two step procedure be applied. The sample was designed by taking into account the uneven distribution of housing in urban and rural areas yielding a certain percentage of investigation to the urban zones in order to get the adequate results. This meant that the major urban areas (four largest cities) received 5-10% more starting points for investigation.

2.3. Phase A of the survey

This phase has been designed as a quantification process that was conducted according to the following postulates:

• It was conducted as an ad hoc survey

• The trained enumerators collected all the data about the buildings on site.

• Explanatory charts were derived by the Faculty of Architecture in order to explain the nature and structure of data.

• The territory of Serbia was divided into zones defined by the census principles (6 zones, 25 administrative districts).

The sample itself consisted of approx. 6000 residential buildings throughout Serbia (excluding the territory of Kosovo), and it was based on 2002 census, migration data as well as on ISM's popula-

tion estimation for 2009. The stratification according to the type of settlement urban/rural was also done for all 25 administrative districts of Serbia. A starting matrix was based on polling place area (approx. 200 households), chosen according to the probability proportional to size sampling (PPS). From starting point every third building was recorded. In this phase basic information about buildings was recorded: address, type of the dwelling unit (as explained in Fig.1), complexity of the ground plan, number of floors, number of apartments, total area of building (estimation), opening ratio, type of windows, photograph of the building (according to pre-set principles).

2.4. Phase B of the survey

The second phase had more of an in-depth approach with regards to the data collection and included interviews with residents. For this phase every 5th building identified in phase A was analysed in detail, resulting in a sample of approx. 1200 buildings. The data that had to be collected was structured in six sections according to the type:

A. Building/House data: year of construction (in accordance with predefined periods), existence and using of the attic and basement space

B. Roof: type of the roof, whether it had thermal insulation, thickness of insulation, type of roofing (by material applied)

C. Outer walls: main building material, average thickness of walls, existence of thermal insulation, thickness of insulation, completion of the facade.

D. Windows: age, condition (estimated), type, existence of the shutters/blinds

E. Heating system: total area of the apartment, heated area, the main heating system, number of furnaces/boilers, additional heating, fuel used for heating, whether the temperatures are kept at desired levels during the heating period, has any part of the heating system been replaced in last five years and what would contribute to better heating in your apartment.

F. Demographic profile: number of household members, age profile.

3. PRELIMINARY FINDINGS

The obtained information illustrated all diversities of the building sector in Serbia and many problems that will have to be solved to contribute towards improving the energy efficiency. From the point of view of energy conservation, the application of thermal insulation represents the most valuable finding. (Fig. 3) Although we can see that the use of insulation increased by more than 40% in the last two decades it is still not sufficient even under the old regulations, especially if we know that 80% of buildings have only 5cm of width insulation.

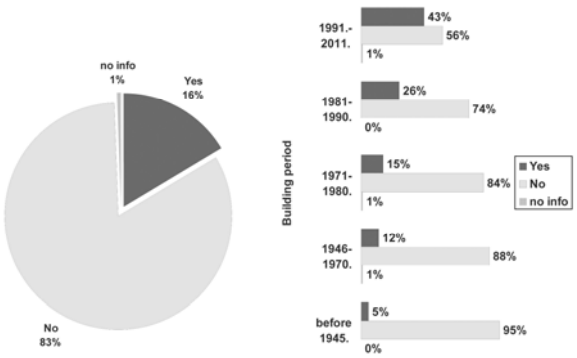

Figure 3. Use of thermal insulation

There is also a large amount of data that deals with a fact which was previously taken into account but not at a sufficiently high level – completion of facade. (Fig.4). Although there are buildings even older than 40 years, and in full use, they still have no facade, which can be partly explained under the taxing regulations according to which such structures are considered as “work in progress”, but also with the standard of living, whereby the quantity (size of the building) exceeds the quality (achieved comfort of living).

If we add to this the average area heated by the occupants (Fig. 5) it is evident that the building stock represents a field for major improvement leading not only towards the reduction of energy consumption but, at the same time, raising the comfort of living without increasing the overall energy consumption.

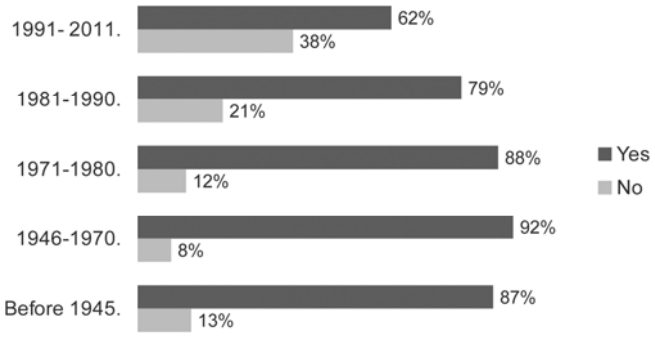

Figure 4. Level of facade completion

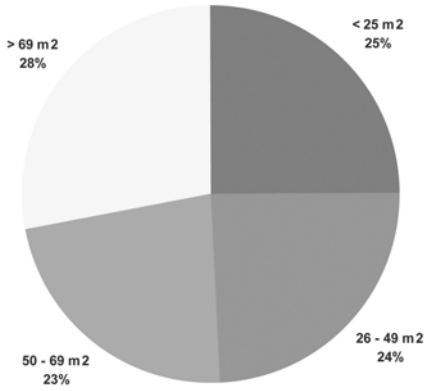

Figure 5. Size of the heated area

4. PRELIMINARY TYPOLOGY

The definition of typology has been achieved in a matrix scheme (Fig.6) for the whole territory of Serbia, as an illustrative chart regardless of the statistical benchmarking. It has been presented as a collection of "model buildings", acting as the visual representations of statistical averages of all analysed buildings for a certain position in the chart. As such it only illustrates a variety of buildings and exceeds the TABULA matrix that consists of only four building classes (free standing, terraced, collective and apartment blocks).

Further work focuses on definition of averages in the field of size, form, construction techniques, materials used, systems applied and technology and, of course, energy consumption. All representative buildings will be modelled in appropriate software (in accordance with the Serbian regulations concerning Energy Performance Certificate issuance) thus providing the data on estimated consumption. Cross referencing with real representations in the form of energy bills collection is to be done and models readjusted if found necessary.

Improvement measures are also to be calculated at two levels:

- The first level will improve the building envelope in a way to meet the regulations for new constructions, which largely exceeds the prescribed level for major renovations and reconstruction. According to the current subordinate legislation the improvement of existing buildings must raise the level of energy consumption by one class only (from EPC). These measures will cover the standard building practice techniques and standard design solutions, enabling easy application.
- The second level of improvement will try to raise the overall performance of model buildings up to the "low energy standard" again using the common methods with reasonable investment resources. This level will try to impose novel solutions and technical systems as a demonstration procedure.

Two levels of improvement of model buildings will define the potential for energy savings, materials and equipment quantities, payback period (according to the projection of energy costs increase) and will serve as a starting point for decision making for the government bodies, private entities and construction companies. Statistically relevant estimations at all three levels (existing, improvement 1&2) and projections will be made providing total energy savings and market potential.

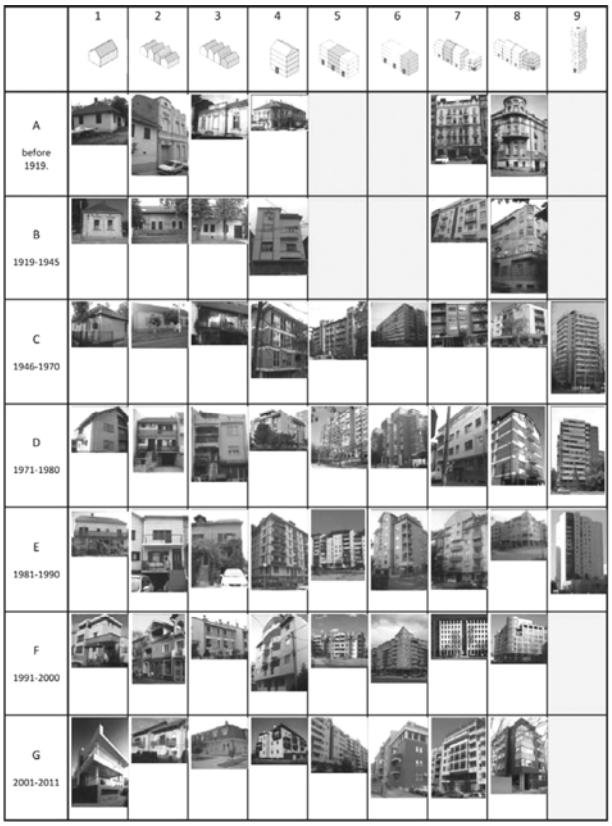

Figure 6. Preliminary Serbian residential building typology

5. CONCLUSION

The energy performance of building sector in Serbia has not been explored in full and a lot of misunderstanding exists even among the professionals. Relevant regulations in this field are divided between several ministries making the decision process very slow and complex.

By making the national residential building typology together with the improvement levels and calculations we will be able to adequately formulate strategies needed to manage the building stock in an energy-conscious way. Experiences derived from this research will address a wide range of participants from private owners, market orientated companies, financial institutions and government bodies.

6. REFERENCES

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НАЦИОНАЛНА ГРАЂЕВИНСКА ТИПОЛОГИЈА КАО ИЗВОР
ЗА АДЕКВАТНУ ПОЛИТИКУ РЕХАБИЛИТАЦИЈЕ

Сажетак: Актуелни Закон о планирању и изградњи Републике Србије регулише питања енергетске ефикасности у зградама, и заједно са сетом подзаконских

аката третира и постојеће и новопројектоване објекте. Имајући у виду да у Србији постоји око 3.200.000 стамбених јединица, указала се потреба за формирањем националне типологије која би била основ за формулисање одговарајуће стратегије у овом сектору.

Након прикључења европском пројекту TABULA (Typology Approach for Building Stock Energy Assessment), приступило се формирању националне типологије према методологији овог пројекта, уз уважавање локалних специфичности. У циљу добијања релевантних улазних података, спроведена је обимна анкета и истраживање на терену. Националном типологијом идентификовани су карактеристични објекти за које су испитани различити модалитети унапређења од минималног задовољења постојећих стандарда, до постизања виших енергетских разреда.

Рад објашњава методологију, процедуре и локалне специфичности овог процеса уз приказ карактеристичних проблема и потенцијала датог приступа.

Кључне речи: стамбене зграде, типологија, енергетска ефикасност, регулатива.