Large-panel dwelling building, current state – ways of construction and architectural modifications.

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ABSTRACT: In this paper was inserted statistic date of dwellings stocks in Poland, prefabricated dwellings systems using in Poland between 1950-1995, present - day requirements of the existing large-size panel building, ways of construction and architectural modifications of this buildings.

INRODUCTION

Building in the people clusters is aimed to create the environment for man life and his needs. Man life in the huge clusters and economical issues have influences into rising huge urban agglomerations. In Poland, growing expanse of urban developed areas and reduction of the costs of housing caused from 50's to 90's creating of characteristics for this period perpendicular's buildings shapes - "large-panel building". The new settlements of multifamily buildings with characteristics "box's shapes houses" have been rising.

STATISTIC DATE OF DWELLINGS STOCKS IN POLAND

Poland is located in the Central Europe. Poland covers an area of 312 690 km². The longest distance from East to West is about 800 km and from North to South about 750 km. Poland has a population of 38 654 000 million averaging 124 persons per 1 km². 23 908 000 people live in cities and urban areas. Poland has not a high standard of housing. On an average, the population has at its disposal 1,04 rooms per person. State-owned firms for non-profit housing associations built most of the housing in Poland in period-1945 – 1995. These associations constitute an instrument for realizing public housing and building policy. The associations have played an important role in the long-term development of industrialized housing in Poland. At present time most of the housing in Poland is build by private firms for private investors. Poland has a temperate climate with cold winters and warm summers. The winter temperature between 15 – 20 °C degrees below zero the summer temperature normally between 20 and 30°C, still with rather great variations.

The west and east are the prevailing directions of the wind. This, combined with rain and a lot of snow and the fact that the temperature passes freezing point an average 50 times each winter and that the ground is freezing to 60 – 80 cm, means high requirements to structures, design of exterior walls, joints, etc. Building activity is not maintained all year round. December, January and February are hard to reach for building activity, because of the weather.

Total area of Poland in 1999 as of 31 December was 312 690 km²
Area of Poland in 1999 as of 31 December per inhabitant was 0,0081 km²
Population of Poland in 1999 as of 31 December based on balances was 38 654 000
Of which
Urban areas 23 908 000
in % 61,8
Rural areas 14 746 000
in % 38,2

Population of Poland in 1999 as of 31 December based on balances per 1 km² was 124.

Poland’s housing stock in 1999 as of 31 December based on balances was 11 763 300
Usable floor dwellings space per person 19,0 m²
Usable floor space per dwellings 61,3 m²
<table>
<thead>
<tr>
<th>year</th>
<th>all units</th>
<th>one-family houses (%)</th>
<th>multi-family houses (%)</th>
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<tbody>
<tr>
<td>1960</td>
<td>142072</td>
<td>19.4</td>
<td>114553</td>
</tr>
<tr>
<td>1965</td>
<td>170446</td>
<td>20.1</td>
<td>136125</td>
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<td>1970</td>
<td>217090</td>
<td>18.4</td>
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<tr>
<td>1975</td>
<td>248117</td>
<td>19.9</td>
<td>151977</td>
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<tr>
<td>1980</td>
<td>193090</td>
<td>14.8</td>
<td>114553</td>
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<tr>
<td>1999</td>
<td>81979</td>
<td>1.2</td>
<td>81015</td>
</tr>
</tbody>
</table>

Table 1. Dwellings completed in Poland.

<table>
<thead>
<tr>
<th>Year</th>
<th>Usable floor space in inhabitted dwelling in thous. m²</th>
<th>Dwellings build in large size elements in thous. m²</th>
<th>Dwellings build in other method in thous. m²</th>
<th>Usable floor space in m² per dwelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>410002</td>
<td>502649</td>
<td>633107</td>
<td>50.7</td>
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<td>1978</td>
<td>430192</td>
<td>512649</td>
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<td>1988</td>
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<td>1995</td>
<td>706097</td>
<td>430192</td>
<td>61</td>
<td>63.9</td>
</tr>
</tbody>
</table>

Table 2. Dwellings stocks based on census data.

**PREFABRICATED DWELLINGS SYSTEMS USED IN POLAND BETWEEN 1950-1995**

**Large size-elements system.**

Dwellings system with large-size elements. That system was used in Poland started from 1950 year. In this system building structure was arrangement as crosswise, lengthwise and mixed configuration. Crosswise configuration was the main arrangement used in this system. Modular grid 60 x 60 cm was put into use in horizontal projection of storey. Span ceilings were 600, 480, 360, 240 cm. Ceilings were 22 cm fat. Main walls were 15 cm fat. Storey height was 280 cm, in cellar 250 cm.

**Figure 1. Large size-elements system.** Building structure was arrangement as lengthwise configuration. (ref. Lewicki B., 1962)

**Figure 2. Large size-elements system.** Building structure was arrangement as crosswise configuration. (ref. Lewicki B., 1962)

**Graph 1.** Dwellings stocks based on census data. Mai 1995.
Large panel elements system.

Dwellings system with large-panel elements. That system was used in Poland started from 1955 year. Modular grid 60 x 60 cm was put into use in horizontal projection of storey. Span ceilings were 600, 480, 360, 240 cm. Ceilings were 25 cm fat. Main walls were 15 cm fat. Storey height was 280 cm, in cellar 250 cm.
**Skeleton construction system.**

Open dwellings system with pillar and horsehead elements. Skeleton construction system was used in Poland between 1954-1958 year. In this system building structure was arrangement as plate-skeleton configuration. Crosswise configuration was the main arrangement used in this system. Modular grid 60 x 60 cm was put into use in horizontal projection of storey. Span ceilings were 480, 240 cm. Ceilings were 14 cm fat. Main walls were 15 cm fat. Storey height was 280 cm, in cellar 250 cm.

**W–70 System.**

Open dwellings system with large-size elements. W – 70 system was used in Poland started from 1970 year. In this system building structure was arrangement as crosswise, lengthwise and mixed configuration. Crosswise configuration was the main arrangement used in this system. Modular grid 60 x 60 cm was put into use in horizontal projection of storey. Span ceilings were 600, 480, 360, 240 cm. Ceilings were 22 cm fat. Main walls were 15 cm fat. Storey height was 280 cm, in cellar 250 cm.
Figure 11. W –70 System. Methods of houses forming. (ref. Węglarz M., 1972)

Figure 12. W –70 System. Example of flats forming. (ref. Węglarz M., 1972)

Figure 13. Example of facades in W-70 system. Poland (ref. Węglarz M., 1972)
**Szczecin System.**

Open dwellings system with large-size elements. Szczecin system was used in Poland started from 1971 year. In this system building structure was arrangement as crosswise, lengthwise and mixed configuration. Crosswise configuration was the main arrangement used in this system. Modular grid 60 x 60 cm was put into use in horizontal projection of storey. Span ceilings were 480, 240 cm. Ceilings were 14 cm fat. Main walls were 15 cm fat. Storey height was 280 cm, in cellar 250 cm.

Figure 14. Szczecin System. Configuration of building structure elements. (ref. Weglarz M., 1972)

Figure 15. Building structure was arrangement as cross configuration (ref. Weglarz M., 1972)

Figure 16. Szczecin system. Building structure was arranged as two-way configuration (ref. Weglarz M., 1972)

Figure 17. Szczecin System. Building structure was arranged as crosswise configuration (ref. Weglarz M., 1972)

Figure 18. Example of facades in Szczecin system. Poland (ref. Weglarz M., 1972)
CHARACTERISTICS OF THE LARGE-PANEL BUILDING.

The large-panel building consisted in an initial prefabricating of the building elements. The buildings were built with mix or crosswise constructional system. Basement made from prefabricating elements founded on continuous footing poured out on the building site. Ceiling above the last storey usually was used as ventilated roof ceiling. The buildings were made with height: to five storeys without the passenger's lift shafts, to eleven storeys or higher with passenger's lifts and rubbish chutes. In the prefabricating elements plants there have been produced in the industrial way, on ready prepared technological lines the elements like: ceilings, inside walls with door's holes, outside shelter walls with ready made textures, outside walls with window's holes and balcony's door holes, balcony and loggia panel's elements, staircase landings and flights of staircases.

EXISTING PROBLEMS OF THE PREFABRICATED MULTI-STOREY BUILDINGS.

REQUIREMENTS OF THE PRESENT DAY BUILDING.

The requirements of the present day building have changed a lot in last years.

Architectural requirements.

The present day apartment house has increased the requirements for using modem forms. Varied buildings solids, implementation of the new materials, determine a new level of those buildings. Quantity of the architectural forms and spatial compositions joined with usage of materials and surface textures requires implementing of different constructional solutions.

Usable requirements.

Change of the life standards makes building of the flats in the way, which gives the possibility of easy change of the flats development shape. Easy of forming the living space with possibility of free adapting to own needs is a very important factor, which have influence to the shape of present day building. The requirements for ground floor development, which are usually dedicated for services are even bigger. Development area and flexibility of its usage by the users. It requires to use a big spans usually founded on the pillars net made out in the way which allows easy exchange and arrangement of the elevation and usage area developing and their quick adopting for the running activity.

Buildings made of the large-panel - possibility of adapting it to present-day architectural requirements. Present-days housing and service building results from social needs. New community needs for bigger living area allows the architects forming with bigger momentum and implementing the variety of forms and unique of shapes.

The question arises: what to do with the buildings made from large-panel, which form monotonic housing estate development built in previous years? By the aesthetic matters and new needs for living area they can be demolish. Looking through the economic side - are we able to afford for such a drastic move? Compromise seems to be the only reasonable solution.

Adapting the large-panel building to the present-day social and architectonic needs requires introducing constructional changes. Construction strengthening for roof shape change, change of usable room spans, adapting to heat energy consumption requirements. All of those changes are in order to adapt of large-panel building to the present day architectural needs and to meet functional and aesthetic users expectations.

INSIDE EXCHANGES OF EXISTING LARGE-PANEL DWELLING BUILDING. FLEXIBILITY OF INSIDE AREA ("BIGGER / SMALLER").

Flats area enlarging.

Due to usable matters its is often required to enlarge flats area. Large-panel housing offers small flats with specialised small usable area rooms. Building made out of large-panel technology are usually used in mixed construction system. Flats area enlarging can be achieved in two ways, through joining the flat on the same level or joining neighbourhood flats on two following storeys. Enlarging the usable room's and flat's area in its level involves with removal of the wall — one of the building construction element. To ensure load transfer, construction and users safety it is required to exchange disassembled wall with another element. It seems rational to use beams, which are founded under the ceiling transferring loads on the vertical construction's elements. It is constructor skill to joint knots shaping and calculating construction stability.
Construction solutions should not constraint architecture visions and usable room’s height. Rooms developing through joining flats on two storeys can bring another troubles. Joining flats on two neighbour’s storeys makes transportation problems. Easy transportation between storeys has to be assured. The most common element are staircases seldom passenger lifts. It makes additional troubles because of ceilings that are construction elements. How to put stairs in safety way into the ceiling which originally had no holes?

Changing of first floor area in existing large-panel flats buildings.

First floor area in existing large-panel flats buildings like others floors in this type of buildings are used for dwellings. For changing the quality of live of occupant of the houses ought to be move in new function for example: shops, restaurants, clubs, recreation areas, cultural service, etc. This function needs other construction utilities.

OUTSIDE EXCHANGES OF EXISTING LARGE-PANEL DWELLING BUILDING.

Adding vertical elements.

Outside exchanges of existing large-panel dwelling building can be done by adding new vertical elements.

Composition of the roofs covers.

In the low buildings change of roofs shape seems to be rational solution. Change of the roofs shape varies building shape and can make at the same time its renovation or possibility of flats development. Change of the roofs construction for rafter framing often forcing the load increase on the last storey. That load can increase itself because of application of heavier roof covering, usage of attic as additional usable floor space. Construction of the ceiling in the shape of ferroconcrete panels unable direct load transfer to ceiling. It seems rational to use steel or wood construction - which is light -strengthening and reinforcing additional loads on the building walls. The whole construction should be light with possibility of easy assembly. We ought to be able to assembly such construction near the existing building, on the ground and afterwards put it up of the building. Such constructions should be able to transmit the usable loads and dead weight on responsible construction elements. Additionally the heat insulating power and noise protection requirements in the rooms for people should be met.

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Adding horizontal elements.

Changing of shape of existing large-panel flats buildings by adding new elements: new parts of building.
Changing of first floor area in existing large-panel flats buildings plus adding new elements outside of the building.

Improving of quality of connections of elements in existing large-panel flats buildings.

Sometimes there are problems with connection of elements in existing buildings. Specially with balcony elements.

Increasing of thermal comfort.

Rising prices of heat energy and requirements for thermal comfort makes necessity to apply additional heat insulation on buildings. Large-panel buildings whose outer partition walls include low layer of insulating materials characterise high heat transfer coefficient, which follows lowering thermal comfort and high exploitation costs. There is necessity to make additional thermal insulation on the existing buildings to reduce cost of its using.
The most frequently used in Poland method of heat insulation is light method. It consists in increasing of wall's thermal resistance through laying the insulating material on the outer surfaces. The insulating material is mainly foamed polystyrene, which is joint to the walls by glue materials and mechanical elements. This elements are additionally strengthen with plastics nets and covered by plaster mortar.
Advantage of this method is thermal bridges total liquidation, speed and execution simplicity.
In the buildings with higher finishing quality requirements, there are often nobly finishing material used. In that case the outer wall's surface is putted on a framework between which the heat insulation panels are fixed.

Elevation aesthetic raising.

The large-panel buildings aesthetic value has devaluated a lot in last years. In order to change its view different solutions can be applied.
The simplest one seems to be an application of a new colouring of the elevation. It can be made together with thermal renovation. There are new textures used such as acrylic or mineral plasters laid after heat insulation making or as facing of ready made elements in the shape of panels.
More advanced one solution for elevation view improvement is its total change. It seems to be possible to exchange the outer walls with new constructions with the simultaneously change of its architecture, which enables the change of view and possibilities for buildings adaptation. The question arises how big influence has the change of the elevation on the building construction's stiffness.
It seems to be possible to change the shape of the building by its partial demolition. Disassembling of a few storeys from the perpendicular's shape building will vary its body.
We can add new elements which can change elevations and help us to enlarge flats area.
**CONCLUSION.**

In Poland, first problem is that, we must to demolish about 800,000 dwellings because of their technically poor condition level. Also, we have approximately 300 dwellings per 1000 inhabitants in Poland, nowadays. This coefficient is one of the lowest in Europe. We must build about 1,500,000 dwellings because of our social needs in Poland. So in total, we need about 2,300,000 new dwellings in Poland in near future.

Second problem is, how to accommodate to new social needs dwelling-buildings which were been done with using of prefabricate technologies in last 5 decades (between 1950-1995 year). In Poland, large-panel building started in fifties and continued by forty five years was in order to meet the social flat requirements, towns' developing together with the cost reduction. The simplest solution was mass-production.

In advance preparation of the typed building elements speeded up the assembly and increased the quantity of putted to use buildings - that was the matter.

Do the buildings which have exist for dozens of years, must to be change? If we look at present day flat and service development, that direction is unavoidable. Due to still high cost of development, the large-panel building is going to be used. One more possibility remains — adaptation of the buildings to actual housing and servicing needs.

**What is most needed – here and now?**

Improving of quality of connections of elements in existing large-panel flats buildings.

Increasing of thermal comfort in existing buildings. Because of climate conditions we must change composition of the existing roofs covers. In the low buildings change of roofs shape seems to be rational solution. While we will change of the roofs shape we can varies building shape and we can make at the same time its renovation or we have possibility of increase number of flats in existing building.

Another thing is problem of changing first floor area in existing large-panel dwelling buildings. Nowadays social needs shows that we need more space for retail trade or for handicraft in neighbourhood of the flats. We can find the area for it on the first floor in existing buildings.

**What we will need tomorrow?**

Flexibility of inside area in existing large-panel dwelling buildings ("bigger / smaller"), we will need flats area enlarging.