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HISTORY AND PERSPEKTIVES OF PANELING BUILDING-UP. PART I.

Darja KUBEČKOVÁ SKULINOVÁ, Kateřina KUBENKOVÁ
Technical University of Ostrava

1. Introduction

Housing development is an integral part of activities carried out by each company. In terms of evolution, there are various forms in the housing development – they differ in the level of user standards, structural systems, materials and technologies. One of technologies used for the housing development uses pre-fabricated panel blocks for the construction. The pre-fabricated panel blocks forms the assembled structural systems in multi-family houses. Typical structures are panel, skeleton or combined [1].

Because from the 1950s to the 1970s multi-family panel block buildings resulted in negative experience, at the turn of the new millennium people were interested little only in this type of construction. It should be, however, pointed out that each complete building work needs to be maintained properly and regularly throughout it service life, and this is the aspect that has been underestimated considerably in case of the multi-family panel block buildings.

The panel structure is significantly affected by correct diagnostics of defects, failures, and faults as well as by selection of suitable remediation projects, technologies and materials.

It follows from practical experience and new research findings that the role played by the panel block construction with various construction solutions in development of housing stock is irretrievable. The panel block construction combined with various materials provides an optimum solution for housing development in terms of technology, operation, aesthetic value and economy. Such flexibility, however, needs consistent pre-production preparation of the construction, including a pre-design and design preparation, and a careful construction process.

1.1. History of the panel block construction

The pre-fabricated panel block technology started developing in the Czech Republic as early as in 1945, almost immediately after the end of the World War II. After 1948, the construction business focused on industrial constructions mainly. This means, the quantity was of key importance. Such approach had negative consequences and the society perceived panel block technologies negatively. It should be, however, pointed out that the European countries had to solve the housing and civic amenities, this being, in particular, the case of

times after the end of the World War II. From this point of view, the panel block technologies seemed to be a good solution. Below are reasons. The construction industry was, in those days, the key driver of the economy and the silicate block business was flourishing then (Table 1, chart 1). The panel block construction technology accelerated the building process – it was possible to assemble the blocks in winter (and the building works were not dependant on the time of the year anymore) and because of central production plants that were fabricating the panel blocks the work became less demanding. In the second half of the last century, the panel block technology became very popular in construction of multi-family house, civic amenities buildings or in construction of fabricated industrial halls.

Table 1. Prefabrication in multi-family housing development in the Czech Republic from 1955 to 1970

Year	Prefabrication (%)
1960	About 20 % of multi-family construction business used fully prefabricated panel blocks.
1965	Prefabrication was used in 58% of multi-family building construction.
1975-1980	Prefabrication reached more than 90%.

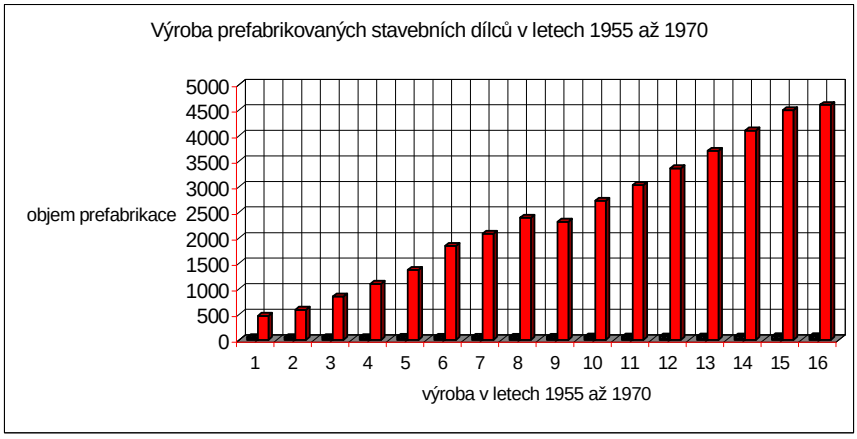

Chart 1: Production of prefabricated blocks (m3/year), since 1970, the trend in production of prefabricated blocks was more than 4.6 million m3/year

1.2 Panel block construction in the Czech Republic and in the Ostrava-Karviná region

In the Ostrava-Karviná region, the panel block construction was used in:

a) housing development,
b) construction of civic amenities,
c) construction of industrial plans (light/heavy industry plants – typically heavy one-floor halls),

In case of the multi-family housing development, wall panel blocks were the preferred solution. A skeleton system with fabricated external cladding was used less frequently (see Table 2).

In the construction of civic amenities, fabricated skeleton structures with a fabricated external cladding.

The first attempt to build a residential area with multi-family houses and to use panel blocks for that project appeared in Ostrava as early as in 1946. From the urban pattern point of view, this was a concept of a comprehensive solution to a rather big territory. This was the first plan-based impulse which turned to be a system in the Czech Republic. The urban concept of the Ostrava-City started developing in 1950 and 1951. The conceptual works became very beneficial for the systematic housing development in the region of Ostrava. In fact, this concept was the starting point of the modern town planning in the Czech Republic. In Ostrava, ideas were presented about general housing development, civic amenities, advanced investments into buried networks or urban concepts that were, later on, used by city planners in other Czech towns (source: History of Ostrava, archives).

It was the region of Ostrava, where the panel block construction business developed most in the Czech Republic. Throughout years of the intensive panel block construction, the quantity of panel-block buildings became important instead of their quality. Failures and defects of the panel block buildings became evident. Regular maintenance and repairs were not carried out - consequently, the prefabricated panel block buildings degraded even more.

Since the end of the 1950s, more than fifteen basic/core panel block systems were registered and used for panel block construction. Various regional variants existed – they were dependant on materials typical of that region (see Table 2). In Ostrava which was the centre of heavy industry, slag, flying ash and similar materials were used. In the Czech Republic, more than fifty variants of the modified panel block construction systems existed - in the Moravian-Silesian Region, there were about thirty such variants [2].

Table 2. Structural systems used in the panel block buildings in the Czech Republic from 1955 to 1995

Structural system	**Modified variant**	**Modified variant typical of the Ostrava-Karviná Region**	**Used in construction since**	**Note**
T 11, T 12	-	-	1950	Construction everywhere in CZ.
G 40	G 50, G 56, G 57-OL, G 58, G 59	**G 57, G 57-A, G 57 3.P**	1955	Construction everywhere in CZ.
T 13, T 16	-	-	1955	Construction everywhere in CZ.
T02B	T02B.A	**T02B-OS**	1962	Construction everywhere in CZ.
T03B	T02B-3B	**T03B-OS**	1965	Construction everywhere in CZ.
GOS	GOS 64, GOS 66	**GOS**	1960	Ostrava, Moravian-Silesian Region*
	T06B-PSP,	**T06B-OS, TO6B-**	1965	Construction

T06B	T06B-KV, T06B-E, T06B-KDU, T06B-OL	**BTS, T06B-OS-R, T06B-OS-70**		everywhere in CZ.
T07B	-	-	1965	Experimental structural systems.
T08B	-	-	1965	Experimental structural systems.
T09B	-	-	1965	Experimental structural systems.
PS 61	PS 69, PS 69/2	-	1965	Bohemia.
VOS	-	**VOS 66**	1965	Ostrava, Moravian-Silesian Region.
VMOS	-	**VMOS**	1970	Ostrava, Moravian-Silesian Region.
VPOS	-	**VPOS**	1970	Ostrava, Moravian-Silesian Region.
BP 70	B 70/R, B 70/ Sč	**BP-70-OS**	1970	Construction in South Moravia and North Moravia, and in North Bohemia.
BANKS I/1L	-	-	1972	Construction in North Bohemia.
Larsen-Nilsen	-	-	1972	Construction in Prague.
HK	HKS-70, HK-69, HKS-G	-	1972	Construction in East and North Bohemia.
VVÚ-ETA	-	-	1972	Construction in Prague and North Bohemia.
OP1.1	OP 1.1, OP 1.11, OP 1.21, P1.11, P1.13	**P1.11, P1.13**	1984	Construction everywhere in CZ.

*Moravian- Silesian Region = MSK

1.3 Typical structural systems used in the multi-family panel block houses in the Ostrava-Karviná Region

From 1998 to 2008 the author1) collected data from the monitoring of panel block buildings during a building and technical survey of the multi-family panel block buildings in Ostrava and Havířov. It follows from the findings that certain structural systems used in the multi-family panel block buildings are typical of the Ostrava-Karviná region and do not occur in other regions of the Czech Republic where such information has been taken from specialist literature.

Table 2 shows that four structural systems are entirely different – from the point of view of construction arrangement and, in particular, from the point of view of materials used in the external cladding. These are the structural systems GOS, VOS, VMOS and VPOS – see Table 3 and Figures 2 through 5. If compared with the other structural systems used in the Czech Republic, those systems were modified to reflect specific features of the Ostrava-Karviná Region and to provide protective against mining effects. Table 3 shows an overview of the panel block houses which are typical of the Ostrava-Karviná region.

Table 3. Structural systems of the panel block houses typical of the Ostrava-Karviná Region

Structural system	Modification/characteristics
T11, T12*	T11 and T12 are the systems used for construction of multi-family houses in, what is called, a two-year-plan residential areas. Its structural features and materials are not typical of the houses made from fabricated panel blocks. Those buildings were built in first years after the World War II. The system consists of a longitudinal panel block wall system with an inclined roof and ceramic ceilings.
T 13, T 16*	This system is not classified as a system used for buildings made from fabricated panel blocks. The system uses a semi-fabricated technology. The wall system (either along the wall or in two directions) is assembled from building pieces. The ceiling is ceramic and the roof is inclined. Such buildings are typical of housing development which is referred to as "Sorela" (social realism style used in the housing development)
GOS	**GOS 64, GOS 66** The system of panel block construction was used for construction of multi-family houses in undermined territories of the Ostrava-Karviná region, see Fig. 1.
T02B*	**T02B-OS** This system of panel block construction was used in the whole of the Czech Republic. In the Ostrava-Karviná region, structural modifications were introduced to protect the buildings on the undermined territory. The modified system differs from the standard system by materials used in the external cladding and roofing.
T03B*	**T03B-OS** This system of panel block construction was used in the whole of the Czech Republic. In the Ostrava-Karviná region, structural modifications were introduced to protect the buildings on the undermined territory. The modified system differs from the standard system by materials used in the external cladding and roofing.
T06B*	**T06B-OS, TO6B-BTS, T06B-OS-R, T06B-OS-70** This system of panel block construction was used in the whole of the Czech Republic. In the Ostrava-Karviná region, structural modifications were introduced to protect the buildings on the undermined territory. The modified system differs from the standard system by materials used in the external cladding and roofing.
VOS	**VOS, VOS 66** The system of panel block construction was used for construction of multi-family houses in undermined territories of the Ostrava-Karviná region, see Fig. 2.
VMOS	The system of panel block construction was used for construction of multi-family houses in undermined territories of the Ostrava-Karviná region, see Fig. 3.
VPOS	The system of panel block construction was used for construction of multi-family houses in undermined territories of the Ostrava-Karviná region, see Fig. 4.
	BP-70-OS

BP-70*	This system of panel block construction was used for construction of multi-family houses in mostly in the north and south of Moravia. In the Ostrava-Karviná region, structural modifications were introduced to protect the buildings on the undermined territory. The modified system differs from the standard system by materials used in the external cladding and roofing.
OP1.1*	**P1.11, P1.13** This system of panel block construction was used in the whole of the Czech Republic. In the Ostrava-Karviná region, structural modifications were introduced to protect the buildings on the undermined territory. The modified system differs from the standard system by materials used in the external cladding and roofing.

Comments:

This systems used for the housing development based on panel blocks occur only in the Ostrava-Karviná Region. They have not been used in other locations in the Czech Republic.

***** These are systems that are typical of construction of the multi-family panel block houses in the Ostrava-Karviná Region.

Regional variants of the structural systems	
Photo	**Description of the structural system**
 Fig. 2. Structural system GOS	- This is a transversal structural system. Reinforced concrete walls are available as a 3,60 m module. - Multi-family panel block houses have got from 8 to 12 floors. - Load-carrying walls inside the building are made from reinforced concrete or slag concrete blocks. Thickness: 160 mm. - External cladding is made from gas silicate window sills (thickness: 240 mm) and spandrels. The gable is made from slag concrete blocks. U = 1,45 $Wm^{-2}K^{-1}$ (SPB), U = 1,04 $Wm^{-2}K^{-1}$(PSK). - Partition walls are made from slag concrete blocks, thickness: 80 mm. - Asphalt roofing has one layer only, U = 0,95 $Wm^{-2}K^{-1}$. - Roof structures are made from reinforced concrete, thickness: 100 mm.
	- This is a skeleton structural system made from reinforced concrete. There is a reinforcing monolithical core in panels. 6.00 m modules are available.

Fig. 3. Structural system VOS

- The multi-family houses have got 12, 14 up to 17 floors. One experimental building with 21 floors was built.
- Load-carrying walls inside the building are made from reinforced concrete. Thickness: 200 mm.
- External cladding is made from window-sill belts from gas silicate, thickness: 240 mm, combined with spandrels. U = 0,80 $Wm^{-2}K^{-1}$.
- Partition walls inside the building are made from reinforced concrete, thickness: 60 mm.
- The roof consists of one layer – some types can be loaded and resist the weight of walking persons. U = 0,78 $Wm^{-2}K^{-1}$.
- The ceiling consists of hollow pre-stressed panels made from reinforced concrete. Thickness: 200 mm and 300 mm.

Fig. 4. Structural system VMOS

- This is a skeleton structural system made from reinforced concrete. There is a pre-assembled wall core in panels. 6.00 m modules are available.
- Multi-family panel block houses have got 12 to 17 floors.
- Load-carrying walls inside the building are made from reinforced concrete. Thickness: 160 mm or 250 mm.
- The external cladding is made from gas silica window sill bands with cogging. Thickness: 240 mm. They are combined with spandrels, thickness: 240 mm or 180 mm. U = 0,80 $Wm^{2}K^{-1}$.
- Partition walls inside the building are made from reinforced concrete, thickness: 80 mm.
- The roof consists of one asphalt layer - some types can be loaded and resist the weight of walking persons. U = 0,78 $Wm^{-2}K^{-1}$.
- Roof structures are made from hollow reinforced concrete panels, thickness: 190 mm.

Fig. 5. Structural system VPOS

- This structural system combines transverse and longitudinal reinforced-concrete walls. 3,6 m modules are available.
- Multi-family panel block houses have got 12, 16 up to 18 floors.
- Load-carrying walls inside the building are made from reinforced concrete. Thickness: 200 mm.
- The external cladding is made from linked gas silicate panels, 300 mm. The face which does not carry loads is made from aero concrete. Load-carrying components are made from sandwich panels. $U = 0{,}43\ Wm^{-2}K^{-1}$ (sandwich panels), $U = 0{,}067\ Wm^{-2}K^{-1}$ (gas silicate).
- Partition walls inside the building are made from reinforced concrete, thickness: tl.80 mm, or from bricks.
- Asphalt roofing has one layer only, $U = 0{,}29\ Wm^{-2}K^{-1}$.
- Roof structures are made from hollow reinforced concrete panels, thickness: 150 mm.

Symbol

U – heat passage coefficient ($W.m^{-}2.K^{-1}$), R´w – airborne sound insulation (dB), U_N – heat passage coefficient recommended value ($W.m^{-2}.K^{-1}$)

Literature

[1] Horáček E.: Panelové budovy (Panel block buildings), Nakladatelství technické literatury SNTL, Praha, 1977.

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