

# RENOVATION QUESTIONS OF INDUSTRIALIZED (WITHOUT PANEL) BUILDINGS

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## Abstract

The paper presents the discussion of block-building and cast-in-situ wall building technologies. The author analyses their evolution, their structures as well as possible renovation methods of multi-storey blocks constructed with such technologies.

*Keywords:* industrialized buildings, cast-in-situ-wall building system, block-building system, maintenance, energy saving.

## 1. Introduction

It was as early as 1985 that the technical problems associated with panel buildings were first worded by experts, who called attention to the necessity of rehabilitation. Numerous solutions have been invented since that time both in my country and abroad for the all-round renovation of such buildings. Articles, essays, analyses, books have been published to fill volumes on the pressing urgency of technical tasks and also on the experience gathered during the renovation of panelized housing estates abroad. The implementation of these renovations is already under way in Hungary and the greatest part of the work is expected to be finished in reasonable time owing to the well organized rehabilitation programme. But that does not mean the end of the mission, since in the early period of industrialized housing (mostly in the 1950s and 1960s) residential buildings were built not only as panel buildings, but also constructed using the pre-walled, the cast-in-situ wall-block technology, or with walls cast-in-situ from light weight concrete. These buildings were built in smaller numbers than the flats constructed with the panel technology that developed next, still their number is not negligible.

In my article I give a short technical description of the two latter groups of buildings and discuss their renovation possibilities.

## 2. The Evolution of Industrialized Home-building

At the end of World War II the housing stock of Budapest was significantly damaged, a large number of families were left without homes. After the battles were finished the clearing away of the rubble was the most urgent thing, then the rebuilding and the reconstruction. After the siege the 'production of flats' primarily meant bringing damaged flats into an inhabitable state and the subdivision of large residences.

At the same time the forced industrialization increased the number of workplaces significantly. This process showed already in the early forties. The possibility of employment combined with the effect of the creation of regional agricultural co-operatives encouraged the influx of the population into the cities. By 1960, in the course of 10 years the population of Budapest grew almost by 215.000.

Because of the terrible housing shortage the construction of new homes became essential. However, the rate of residential construction stepped up only after 1953. Under the economic conditions of those times individual citizens had generally no or little chance of building a home. The role of the state continually increased in the second half of the fifties (judging by the statistics of the period). Although at the beginning new flats were built on vacant sites in the inner districts of the city, from the fifties on more and more housing estates appeared in the regions around the inner districts, then in the outer districts.

The housing estates were initially constructed in the spirit of "socialist realism", however, the socialist realism has come to an end by the end of the fifties. The quality of architecture was not a field of artistic or social issue, construction was chiefly regarded as an economic question. The number of flats to be built and the expenses assigned for that purpose were rationalized. Although the degree of comfort of the new flats improved, the level of architecture decreased. At the same time the typification of design gained ground concerning not merely parts of the structure but the whole building as well [1].

Up to the start of the production of the panel construction system the block-building-system dominated in the building of housing estates. Other typical construction technologies applied table formwork, sliding formwork, floated concrete, later on tunnel formwork.

One may come to the conclusion that after the end of World War II the largest part of home-building activity, which also modified the structure of settlements, consisted in the state-commissioned construction of residential buildings concentrated in certain areas. The building of housing estates was necessary at the time to relieve the large-scale housing shortage. That was also clearly demonstrated by the fact that housing estates were built in all war-struck countries.

## 3. Buildings Constructed by the Large Block-building-system

A typical feature of the large block-building system is that the loadbearing walls of the building are produced as wall blocks whose size and weight was designed

with regard to the capacity of cranes. The convention classified blocks into three categories: small blocks (~ 400 kg/piece), medium-sized blocks (~ 800 kg/piece) and large blocks (~ 1600 kg/piece) [2].

The blocks were made from pre-laid-brick or cast-in-situ light concrete.

In the case of the pre-laid-brick-block technology the blocks were prepared on the ground level among favourable working conditions and lifted by crane to their final position. Such pre-laid-brick-blocks were thus suitable for the construction of both longitudinal and transversal loadbearing walls. The width of blocks was determined by the distribution of wall-openings, 2 meters being the greatest width applied. As far as their height is concerned brick-blocks were produced measuring a third, a half or the whole of the floor-height. The blocks were connected to each other with grooves that were later filled with concrete or with 1,5-2 cm wide joints later filled with mortar. Pre-laid brick-blocks were made alike from stock bricks, perforated and hand blocks [3].

Light weight concrete blocks were made from foamed blast-furnace slag, cinder, chips of reused brick or of volcanic rock. The raw material was most often slag, which was generally available in large quantities in the vicinity of industrial areas.

The dimensions of these blocks were determined by 30 cm module system. Blocks were manufactured in 60, 90, 105 and 120 cm nominal sizes. Blocks of special function included piers, lintels, and parapet blocks as well as blocks with window or door openings. The solid blocks were joined to one another by filling the tube formed by the grooves on the fitting-side of the joined panels with cement mortar prepared with perlite aggregate. The filling had the dual function of insuring the collaboration (joined loadbearing) of the blocks as well as the sealing of the gaps in the marginal walls. Builders tried to achieve perfect tightness of the joints using plastic putty on the external side and oakum-stuffing on the internal side of elevation walls.

The importance of this building method was that it met the technical and economical requirements of mass home-building: the technology that came into being was easy to organize and mechanize and thus it required little human effort.

#### **4. Buildings with Cast-in-situ Walls**

The speciality of the building system of cast-in-situ walls was that the load-bearing walls and the partition walls of the building were made from concrete (without reinforcement bars) cast between formwork of total floor height. The building method is applicable without limitation on the contour of the floor plan, but it is used to best effect for the construction of medium-height and multi-storied residential houses of individual type, [3].

The advantages of the building method were that it required relatively simple machinery and low workforce, it facilitated the construction of walls of smaller thickness and lighter self weight compared to traditional structures and with the

application of light aggregate concrete industrial waste (e.g. foamed blast-furnace slag) was reused.

The author's research was focussed principally on structures built with creeping formwork. I have not studied the construction technology involving the application of sliding or tunnel formwork.

The material of cast-in-situ walls is homogeneous. The basic material of simple walls is light concrete mixed on site most often prepared with an aggregate originating from blast furnaces. The effective porosity of a concrete of such structure is large and because of the watered slag its porosity is large too. The above properties significantly reduce the bulk density of a wall structure as well as its loadbearing capacity but its heat insulating ability is improved. In the case of external walls they applied a thickness of 25-30 cms, because the heat transmission coefficient of such a wall was smaller than that of the 38-cm-thick stock brick wall, which was frequently built at that time. A 25-cm-thick cast-in-situ wall also inhibited airborne sound (48 dB) provided that it had a bulk density of  $1400 \text{ kg/m}^3$ .

The raw surface of a foamed slag concrete wall is quick to absorb water but slow to release the moisture, that is why such a structure had to be elevated 50 cms above the ground level. The plinth was made from ordinary concrete and the facade walls were finished with a solid plaster that was impermeable to moisture.

Cast-in-situ walls required special attention with regard to the exclusion of cracks because of the considerable shrinkage. Cracks could be avoided by the application of longitudinal reinforcement at ceiling height in the perimeter and internal loadbearing walls.

## 5. The Need for Maintenance

In our country about 20 percent of the four million flats were built with the industrialized building system. More than two million people live in these flats. The majority of the buildings constructed with the industrialized technology need renovation. In the course of renewal the basic problem lies in the fact that it has to be done simultaneously in great quantities and also in the varying financial and proprietary circumstances and social standing of the residents.

The energy crisis brought about by the global decrease of fossil energy resources lead to continuously increasing fuel prices in Hungary as well, what makes it necessary to use energy more economically. In our country 25 percent of the annual energy consumption is taken up by the operation of buildings, that is, approximately 300 Petajoules a year. The specific energy consumption of both our nation and the population is higher than in Western Europe. Since part of the energy consumed comes from abroad it has to be obtained at great expense.

Beyond the economic consequences the significant energy consumption also damages the environment. Energy-saving renovation has two purposes (with regard to buildings and their residents): to reduce the energy consumption of the population and to heighten the physical condition and the value of the existing building stock.

On a national level a significant decrease in the energy consumption results partly in a profit for the economy (diminishing energy imports) and at the same time a decrease in the environmental pollution. In the latter aspect the regulations of the international conventions can be enforced.

Heating and hot-water consumption accounts for two thirds of the total energy consumption of the population. Apart from climatic differences, the heat consumption in our country is the double (on the average) of that in technically more advanced European countries.

Our building stock is the most significant element of our national wealth, which is a motivation for further value-creation and the implementation of technical development in harmony with a modern way of life.

The life endurance of buildings is mainly determined by the primary load-bearing system, that is, the endurance of the load-bearing elements. While the expected life endurance of load-bearing structures is 80-100 years, that of secondary and tertiary structures is generally only 15-30 years. If these structures are damaged, it is necessary to repair them periodically or to replace them. Within the activities of maintenance energy-saving restorations deserve special attention.



*Fig. 1.* Damaged facade of a building built by the large block construction system.

## **6. Characteristic Deficiencies and the Methods of Maintenance**

The first step of maintenance is to determine its aim. It may be either the maintaining of the value of the building through partial or global restoration of its original technical state or the enhancement of its value by restoring it to a more advanced technical level than it had at the time of its construction.

A principal group of deficiencies of industrialized buildings derives from the



*Fig. 2.* Typical gaps along the blocks of a building constructed by the large block construction system.

fact that the technical level of the finishing works and of the interior utilities applied at the time of construction did not equal the high standard of the industrialized construction of the load-bearing structures. Critical biological factors arose from the thermotechnical, humidity and air motion characteristics of flats. These often did not correspond to one another. The inappropriate state of any of those could reduce the efficiency of the functioning of all the others.

Consequently the deficiencies of the buildings in question belong to one of three groups:

1. Deficiencies affecting load-bearing capacity and stability,
2. Deficiencies affecting secondary and inferior structures,
3. Architectural deficiencies.

#### *1. Deficiencies Affecting Load-bearing Capacity and Stability*

The most frequent types of structural damage include deficient construction of the foundation-collar level and of joints as well as the dislocation along the joints resulting from the eccentricity of positioning or of the inappropriate composite action of the structural elements. The leaking of these joints and the deficiencies of the heat insulation could accelerate failure.

The reparation of structural deficiencies (cracks on the joints, inappropriate bearing on the subbasement, etc.) can take place after structural calculations and generally with the application of up-to-date fixing components or adequate grouting.

## *II. Deficiencies Affecting Secondary and Inferior Structures*

These defects typically affect the thermal control, the damp proofing or the noise protection of a building. As far as thermal control is concerned, it is advisable to apply supplementary heat insulation on the facade and the flat roof, and to reduce the heat loss through the windows.

The following systems are available for the supplementary thermal control of external wall structures:

- plaster with heat insulation center, silicate-based plaster-systems, inorganic, fibre insulation + silicate mortar,
- system with intensive heat insulation center and thin crust-mortar; polystyrene foam + plastic mortar,
- ventilated air-gap-system behind intensive heat insulation and crusty-skin, inorganic, fibre insulation + air-gap + covering.

The application of supplementary heat insulation on the internal side is to be avoided because of its unfavourable building physical effects.

The renovation of flat roofs is necessary because of the inadequate heat insulation and water-proofing. That generally does not mean a partial dismantling of the layers of the roof, but installing new heat and water insulation layers (DUO-DACH). Vertical additions to the building are also possible. In such cases the following rules have to be observed: the vertical loads are to be transmitted to the load-bearing walls (directly, if possible), and the roof must be designed not to transmit any horizontal load to the walls.

The reconstruction of the openings of the external walls may be carried out for one of the following reasons:

1. improve weather-tightness, reduction of heat loss in winter by filtration,
2. improve heat insulation, reduction of heat loss in winter by transmission,
3. increase energy gain by radiation in winter and reduction of the radiation load in summer.

The possibilities of implementation are the following:

- apply of united structures (3),
- joint seal gaps (1),
- coat existing glazing (2),
- attach new glass-layer to existing window (2),
- replace windows (1, 2).

Apart from the above the installing of solar components and transparent heat insulation is further means of improving the heat balance of the building.

The following structural parts require special attention and in some cases repair or replacement from the point of view of damp-proofing: base course, facade, flat roof, joints.

Acoustic analysis is needed because inadequate external and internal noise insulation generates acoustic problems.

### *Architectural Deficiencies*

Functionally speaking, the crowdedness of flats could lead to a crisis which lies in the monotonous housing structure (uniform flat sizes, no connection of flats insured) and in the unfavourable floor plans (inefficient arrangement of floor space).

## **7. Conclusions**

The renovation of multi-storey blocks constructed with the industrialized technology is necessary and inescapable. It has to be done in the interest of our national economy, but in Hungary it can be implemented only with the commitment of and support from the state. To the author's knowledge the up-to-date renovations of residential buildings built by block-building and cast-in-situ wall building technologies has not been solved. For this reason it is very important to elaborate the complete rehabilitation of these buildings on the evidence of the presented building technologies and characteristic deficiencies.

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