Workshop 17 - Housing Renewal and Maintenance

Problems of services in panel flat - buildings in the czech republic

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Abstract: The paper deals with issues typical of the housing stock in the Czech Republic. Attention is paid in particular to the reconstruction of panel flat buildings on territories with increased industrial activities. The reconstruction of the housing stock has been under discussion for a long time. Considering ever increasing requirements to reduce the power performance of the buildings, this issue is still very topical. The Czech Republic, being a EU member state has undertaken to fulfil requirements set forth in the Directive 2002/91/EEC. Consequently, certain changes will be needed in the assessment of the housing stock.

1 Construction of panel buildings in the Czech Republic

The panel structural systems for the residential buildings were constructed in the period from 1950 to 1990. The progressive system of panel technologies resulted in very fast construction and versatility of the project documentation. In the then Czechoslovakia, there were fifteen panel structural systems for the residential buildings. The basic systems were complemented with regional alternatives depending mostly on materials available in the regions. The construction of the panel buildings was controlled by state authorities, the aim being to satisfy as fast as possible housing needs. Consequently, quantity was often preferred to the quality. Buildings were constructed on the basis of standard basic data there were divided into two parts: mandatory part and reference part. The mandatory part described structural elements for vertical and horizontal structures, while the reference part dealt with materials used in external claddings of the buildings.

From 1959 about 30% of the total housing stock, this means 1,165,000 flats and apartments, were built using the panel technology in the Czech Republic [1].

In the 70s, first building estates faced failures and damages of the external structures of the panel buildings caused by insufficient thermal properties (for instance, mould and fungi grew in poorly ventilated parts of the building and heat losses were too high). These failures have resulted in creation of a new branch of science, structural physics, and prepared conditions for the drafting of the first “technical heat standard”. The standard has been amended several times, the current wording being in ČSN 730540 – Thermal Protection of Buildings [2]. In the course of time, thermal requirements have become more stringent, this being in particular the case of the heat transmission coefficient $U$ [W.m$^{-2}$.K$^{-1}$]. Before 2002, heat resistance was used: $R$ [m$^2$.K.W$^{-1}$]). See Figure 1. Below is the conversion formula for the two variables:
\[ U = \frac{1}{R_T} = \frac{1}{R_{si} + R + R_{se}} \]

where
- \( U \) is the air-to-air heat-transmission coefficient
- \( R_{si} \) is the heat resistance for heat transmission in the construction inside
- \( R \) is the total heat resistance of the structure
- \( R_{se} \) is the heat resistance for heat transmission in the construction outside
- \( R_T \) is the heat-transmission resistance

**Fig. 1** Development of air-to-air heat transmission coefficient \( U \) [W.m\(^{-2}\).K\(^{-1}\)] according to the current legislative of the Czech Republic. Note: venkovní stěna = external wall, plochá střecha = flat roof

The standard in force from 1994-2002 set out recommended, permissible, and required values. Since 2002, the standard sets our two values only: recommended and permissible.

### 2 State support programme for regeneration of panel buildings

PANEL is a state support programme that grants subsidies for repairs of panel residential buildings in the Czech Republic. The state subsidies are used for payment of interests from loans provided by the State Fund for Housing Development. Good-quality pre-project preparation of the buildings is needed for the granting of the subsidies for the repair, modernisation, and regeneration of the panel houses. Within the preparation, attention is paid to technical aspects, technology, economy, and architecture. The subsidies are provided for repairs of static failures, reconstruction of distribution lines, and improvements in heat parameters. Documents needed include a certificate on fulfilment of economic heating energy demands pursuant to the Act No. 406/2000 Coll. (referring to the Directive - standard [2]). This defines the condition for the fulfilment of the total power performance. It follows from [2] that:

\[ STN \leq 100\% \]

where \( STN \) is the level of heat performance of the building.
<table>
<thead>
<tr>
<th>Level of heat performance STN</th>
<th>Classification</th>
<th>Verbal formulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 40%</td>
<td>A</td>
<td>extraordinary economical</td>
</tr>
<tr>
<td>≤ 60%</td>
<td>B</td>
<td>very economical</td>
</tr>
<tr>
<td>≤ 80%</td>
<td>C</td>
<td>economical</td>
</tr>
<tr>
<td>≤ 100%</td>
<td>D</td>
<td>acceptable</td>
</tr>
<tr>
<td>≤ 120%</td>
<td>E</td>
<td>non-acceptable</td>
</tr>
<tr>
<td>≤ 150%</td>
<td>F</td>
<td>considerably non-acceptable</td>
</tr>
<tr>
<td>&gt;150%</td>
<td>G</td>
<td>extraordinary non-acceptable</td>
</tr>
</tbody>
</table>

*Table 1. Classification of energy performance of buildings [2] (economic consumptions of buildings fulfilling A through D criteria)*

This condition is often fulfilled without general reconstruction of the panel building – this means, replacement of hole fillings in the external cladding, installation of insulation in all structures exposed to cold air (roof, external cladding, first floor ceiling), and optimising of the heating system.

3 Case study

The CIDEAS research centre that was created in May 2005 prepared a case study for a comprehensive reconstruction of a panel flat building prepared on the basis of the standardized structural system T06B-BTS.

The flat building consists of four above-ground floors, one underground floor, and a non-passable section on the edge of the building. There are 12 flats in the building. The building is located in Ostrava. It was constructed in 1976 and is a part of a block of houses consisting of four sections.

In those days, the North-Moravian region used blast furnace slag being a by-product of iron production and a frequent material. The external claddings of the blocks of flats were formed by panels made from slag pumice and concrete.

*Fig. 2 Panel block of flats under question, structural system T06B-BTS*

Individual structures in the building were assessed in terms of thermal parameters pursuant to the legislative in force. Table 2 shows the results. The assumption was confirmed: the building did not comply with the requirements. Two alternative solutions were proposed for reduction of energy demands. The both alternatives included the general thermal insulation of the building, replacement of hole fillings/panellings in the external cladding, and optimising of the heating system. Thickness of the thermal insulation was different for each alternative solution. The first alternative is based on the required values, while the second alternative is based on the recommended values of the coefficient of thermal transmission set forth in the standard [2].
Heat transmission coefficient \( U \ [W.m^{-2}.K^{-1}] \)

Required value \( U_N \ [W.m^{-2}.K^{-1}] \)

Recommended value \( U_h \ [W.m^{-2}.K^{-1}] \)

Required internal surface temperature \( \Theta_{i,n}[C^\circ] \)

Recommended internal surface temperature \( \Theta_{a,n}[C^\circ] \)

condensation

Fulfilment of requirements CSN 730540-2/Z1

| SPB, thickness: 375 mm | 1.40 | 0.38 | 0.25 | 9.50 | 12.63 | Mc,a > Mev,a | non-compliant |
| SPB, thickness: 340 mm | 1.51 | 0.38 | 0.25 | 8.8  | 12.63 | Mc,a > Mev,a | non-compliant |
| SPB, thickness: 300 mm | 1.66 | 1.11 | 0.73 | -1.28 | 4.11 | Mc,a > Mev,a | non-compliant |
| Flat roof | 0.47 | 0.24 | 0.16 | 16.12 | 12.63 | Mc,a > Mev,a | non-compliant |
| Flat roof | 1.16 | 0.60 | 0.40 | 16.29 | 12.63 | Mc,a > Mev,a | non-compliant |

Table 2. Thermal assessment of some structures forming the external cladding – original condition

The thermal insulation proposed for the project included expanded polystyrene and mineral fibres. Thermal parameters (in particular, \( \lambda \) - coefficient of heat conductivity \([W.m^{-1}.K^{-1}]\)) of these materials are similar and the price of materials is reasonable and affordable for the general public. Other thermal insulations have not been proposed.

Thermal and energy parameters were calculated for the both alternatives and expressed in tables and graphics.

| Original condition | 216.0 | 1.49 | non-compliant |
| Alternative 1 | 82.0 | 0.56 | compliant |
| Alternative 2 | 73.0 | 0.50 | compliant |

Table 3. Energy assessment of the building under question

If the proposed actions are taken, the reconstructed panel house T06B-BTS would start complying with the requirements and become economical (for alternative 1) or very economical (for alternative 2), in terms of power performance.

An integral part of the revitalisation is adaptation of the heating system. The case study addressed some aspects of such adaptation. After the thermal insulation is installed, the heat flow into the building will decrease, reaching thus again the balance between heat supply and heat demand. If, during the installation of the thermal insulation, the heat flow entering the building with another heat parameters will not be controlled and decreased (in accordance with the Directive No. 2002/91/EEC on power performance of building), the investment into the thermal insulation will be impaired, to a certain extent.
It is essential to keep in mind that it is not enough to use available thermal regulation valves only to reduce the heat flow. Other actions are necessary - either to change the site of heating surfaces or decrease the temperature of heating water. The task of the thermal regulation valves is to compensate random heat gains from sun radiation and internal sources of heat only.

Once the additional thermal insulation is installed, it is necessary:

a) to re-calculate heat losses pursuant to ČSN 06 0210 for new thermal values (in all rooms).
b) to assess whether heating elements in the individual rooms are not over-dimensioned.
c) to determine a new nominal heat gradient for the heating water using results of b). The new parameters of the heating water for the building should be set using a new central regulation in the connection point at the footing of the building - see e) low temperature operation.
d) to install a central regulation node for equithermal regulation of the heating water in order to make it possible to set the low-temperature operation for the section of the building under question.
e) to check existing thermostatic valves for function under new operation conditions and to make necessary questions (such as the installation of additional valves or electronically-controlled circulation pump in the regulation node).
f) to inform the heat supplier about the decrease in the maximum instantaneous hourly and average yearly consumption of heat (if this is the parameter that influences the price of heat) and, if necessary, to discuss other requirements and demands of the heat supplier.
g) to install an automated control system IRC (existing thermo regulation valves should be removed and internal apartment/room temperature sensors, building’s control systems and cabling for IRC should be installed. The whole system works as an accurate proportional measuring system that measures the heat consumption in individual apartments in line with requirements of the individual users).

The procedure above is essential for economic consumption of heat after the installation of the heat insulation.

It is still possible that after several years following the installation of the thermal insulation the energy consumption will increase again and reach the same values as before the economy measures. In most cases, the reason is operation errors. In order to prevent undesirable increase in the energy consumption, it is necessary to introduce the energy management the goal of which is:

- to ensure correct operation of technical equipment
- to troubleshoot defects and failures in technical equipment and operation procedures
- to reduce consumption of energy
- to document results of energy savings reached thanks to the economy measures
4 Example

The CIDEAS centre prepared a case study providing a general concept for reconstruction of a mounted frame structure MS-OB. The case study dealt with structural, energy performance, and operation aspects of the reconstruction and confronted the original condition of the building with that after the reconstruction.

The building is used as a school. Within the reconstruction, thermal insulation was placed onto the external cladding, roof, and plinth (the aim was to reach the required thermal parameters), wooden double windows were replaced with plastic windows with insulation double glass and coefficient of thermal transmission $U = 1.4 \text{ W.m}^{-2}\text{.K}^{-1}$. The heating system was modified, related changes were carried out in the interior of the building, and distribution lines for technical facilities in the building were adapted. This however did not influence considerably energy properties of the building.

For the building, the field of temperature was evaluated for certain details that are referred to as heat bridges. We have chosen a contact point between the window and a reinforced concrete column. Below are two alternatives:

a) column with a wooden double window, without thermal insulation

b) column with a plastic insulation double glass window, with thermal insulation

![Fig. 3 Field of temperature for detail under investigation](image)

Once the building was reconstructed, the thermal comfort inside the building has increased and energy demands of the building have gone down. The reason is the chart below. It is evident that the heat consumption has gone down by 41 per cent. One of most important and main changes in the heating system was the installation of an interactive system of management and control. The interactive system controls the heating in real time, using optimally the supplied heat. Almost in each room, there are sensors that are connected with the central PC controlling the whole system.
5 Conclusion

The Cideas research centre (www.cideas.cz) prepared two studies for reconstruction of buildings. Each study offered alternative solutions. It should be pointed out that there are several ways leading to reduction of power demands of the buildings. They should be however acceptable in terms of economy, technology, operation, and environment. The best energy is the one, which is not produced in vain.

Bibliography:
ČSN 73 05 40 - 3 (2005): Návrhové hodnoty veličin (Designed Quantities)
ČSN 73 05 40 - 4 (2005): Výpočtové metody (Calculation Methods)

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