Energy conscious retrofit of residential buildings built with industrialized technology

Summary of PhD dissertation

Author: Tamás Csoknyai
Advisor: András Zöld DSc.

The physical and moral condition of the 734.000 flats built with industrialized technology makes the overall analysis of the question of retrofit essential. This analysis must cover the constructional, energetic, thermal, building physical, installational, functional, aestetic questions of the present and renovated state. Not only technical, but also economic, financial, organisational, legal and sociological aspects are to be considered. Present dissertation focuses on fundametal, unsolved questions of building energetics, building physics, installation systems and environmental protection.

The scientific research was based on the study on the Hungarian practice and German experience on the renovation in the former Eastern Germany, the analysis of the Hungarian building stock, computer aided thermal bridge simulation of characteristic joints, statistic analysis of building typologies, results of seasonal monitoring in several different flat types, study of thermographic photographs, questionnaires about satisfaction of dwellers and analysis of heat consumption data of existing buildings.

A general conculsion of the work is the necessity of a complex approach of building retrofit, namely that the renovation measures (insulation, window exchange,heating, ventilation, etc.) must be considered regarding the cross-effects. Energetic, fabric protection, comfort aspects have strong interrelations.

The dissertation can be devided into three main sections. The first part focuses on building physical aspects in three chapters. One chapter analyses the reasons of the mould growth that often occur even if design requirements are fulfilled. It highlights that one reason is the lower internal surface temperature in room corners. Corrected design values are proposed for surface conductance at corners for both fabric protectional and energetic calculations. The second chapter examines two main tools of fabric protection: the external thermal insulation and ventilation and their interrelations. In the third chapter a special type of internal insulation is analysed, the silicate-based insulation that can represent a new generation of fabric protection due to its capillary effect.

The second section deals with energetic aspects of existing structures and retrofit measures. First secondary effects are considered, particularly the impact of additionnal thermal insulation on mean radiant temperature and the obtainable secondary energy saving due to the higher operative temperature. Afterwards the existing structures and building geometries are to be regarded. The dominating share of thermal bridge losses in the thermal balance of buildings are proved with the help of two-dimensional thermal bridge models and a heat loss analysing software developed for this purpose.

The influence of retrofit on the ratio of external and internal heat-flows are examined as well as the consequences on the application possibilities of heat-cost allocators. Other impacts of thermal insulation are also considered: the imact on the time constant of the room and thus the sense of programmed heating.

Thermal retrofit of the building envelope has consequences on the HVAC systems, particularly on the adjustment of the heating system to the new conditions and the realisation of a balanced ventilation system with heat recovery.

Finally the third section gives a nation-wide estimation of the heating energy consumption and the environmental impacts of operating the industrialized building stock. Also the expected savings are calculated here that can be achived with rational retrofit measures.