THE EFFECTS OF DIFFERENT RENOVATION MEASURES ON THE ENERGY CONSUMPTION OF SUBURBAN CONCRETE BLOCK OF FLATS

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Summary

In Finland there is approximately 1.2 million apartments in block of flats and app. 40 % of whole block of flat stock in Finland have been built during short period 1960–1979. Studies have been made on total energy consumption of buildings as well as the effect of different repair measures on the total energy efficiency of these buildings based on measured energy consumption of 727 rental block of flats.

Facade and roof repairs are usually related to their some kind of deterioration, and additional thermal insulation has been part of the repair solution. Facade repairs get good results for heat energy savings but are very expensive also in long period. The most cost effective heat energy saving actions is different adjustment of HVAC solutions.

Keywords: energy efficiency, energy consumption, deterioration, repair measures, service life

1 Introduction

1.1 About Finnish building stock

Starting from the 1960s, concrete structures have become prevalent in Finnish construction. Apartment, office and public buildings, which are commonly made of concrete, make up 34 % of the whole building stock. Between 1960 and 1979 the country produced a building stock of now 30–50 year old buildings that presently make up 38 % of all apartments, office and public buildings and 13 % of the whole building stock [1]. This mass of concrete buildings is essential for its financial and functional impact on Finnish society, where one third of the population lives in apartment blocks.

The main reasons for facade degradation in the Finnish climate are frost weathering of concrete and corrosion of reinforcement induced by carbonation of the surrounding concrete [2]. The estimated value of the Finnish building stock is 360 billion euros [3]. The total repair need of the prefabricated concrete facades of Finnish apartment blocks built in 1965–1995 has been estimated to be 3.5 billion euros if repair methods are chosen according to the technical need [4].

Our built environment in 2030 will consist mainly of the building stock in existence today which is estimated to constitute 65 % of the stock in 2030 [5]. Yet, that building stock does not meet all modern requirements. Development goals have already been set for the built environment including the EU Building Energy Efficiency Directive and the Government's goal for reducing emissions by 80 % by 2050 [6]. It is impossible to reach those goals solely by new construction which means that renovation will play a more significant role in the future. To achieve the objectives it demands action considering existing building stock because it is renewed far too slowly, annually about 1–2 % [7], compared to set objectives. It means that old buildings are not going out of use but new buildings are made and thus total consumption increases.

1.2 Objective

The objective of this paper was to study the energy efficiency of block of flats based on measured energy consumption and effect of different repair methods and adjust of HVAC systems to real energy consumption of those buildings.

2 Research material

The research material consists of a database of measured energy consumption before and after different repair measures.

2.1 Energy consumption database

The energy consumption database consists of measured energy consumption of 727 rental block of flats. The buildings are situated all over Finland and are mostly built between 1960 and 2010. The oldest buildings are from the beginning of 20th century.

The heating energy, consumption of household water, municipal district heated water and electricity used in the building (the apartment electricity not included) has been measured in each building since they were completed. All energy consumption data was scaled corresponding Jyväskylä outdoor climate.

2.2 Energy consumption after repair measures or adjustments

The database includes 119 buildings where has been made various repair measures to structures and adjustments to HVAC solutions. The database includes also the repair costs information. Repaired buildings have been built between 1958 and 2006.

The database related to the effects of additional thermal insulation on heat energy consumption consists of 78 buildings built during 1958 and 1981. These are also situated all over Finland.

3 Results

3.1 Facades and roofs

The additional thermal insulation with new facing of the facade causes approximately a 13.8 % saving in heat energy consumption in the apartment buildings built in the 1970s.

The variation on energy consumption is high, from –34 % to +9.8 %, which intend, that in some cases heat energy consumption has been increased remarkably after repair actions.

The costs of thermal insulation is more than 200 €/m^2. The additional thermal insulation of the facades is cost-effective only when the damage in the old facade necessitates cladding type repair. In most cases the amount of additional thermal insulation was 50 mm or 70 mm. This intends that the renovation was made because of deterioration of old facade, not in the purpose of any energy savings. The original amount of thermal insulation varies between 60 and 140 mm in the buildings made from 1960s to early 1980s.

The thermal insulation of roofs is generally quite good in the block of flats located in suburbs. The roof has a small section of the building envelope in the buildings compared to facades and by increasing the thermal insulation of the roof, only a 0-3 % saving in heat energy consumption can be achieved. The cost of the thermal insulation of roof is approximately 80 €/m^2.

3.2 Windows

According to database, the effect of renewing the windows on the heat energy consumption of the building varied from –16 % to +4 %, while average is –5.0 %. The U-value of the windows made 1970s is between 2.7 and 3.2 W/m^{2}K while the modern windows are in average U = 1.0 W/m^{2}K. Renewing the windows costs typically 100 €/m^2.

Renewing of windows is usually combined with overcladding of facades with additional thermal insulation. According to database, in those cases average energy saving was 13.1 %. And in cases where necessary adjustments to heating and ventilation systems was made during repair, the average heating energy saving was 14.8 %.

3.3 HVAC solutions

Ventilation is the major single heating energy consumer in ordinary Finnish block of flats. The most common system is mechanical exhaust ventilation. It takes one third of whole building’s heating energy. In the buildings which are under or soon becoming in the age of renovation, the ventilation in the flats is usually inadequate. The minimum ventilation according to Finnish building regulations is 0.5 1/h.

According to database, in the made repairs, cleaning and adjustment of ventilation the achieved heating energy saving of the building has been varied between –12 % and +13 % in individual cases. The average change in energy consumption is +2.2 %. This tells that the adjustment of ventilation is commonly mixed up in the buildings.

Municipal district heating combined with water heating radiators is the main heating system in all block of flats in Finland. Many components in the heating system built up in 1970s or before are today in the end of their service life. According to database, adjustment of heating system lowers the energy consumption 3.8 % (–14 % … +5 %) in average. Renewal of heat transfer of the system saves heating energy 4.7 % (–14 % … +5 %) in average and renewal of radiator thermostats 5.7 % (–9 % … +2 %) in average.

4 Conclusions

Several repair measures and adjustments have been made on those buildings during the past years. In most cases there is some kind of combination on different repairs and after that made adjustments of HVAC solutions.

Facade and roof repairs are usually related to their some kind of deterioration, and additional thermal insulation has been part of the repair solution. Additional thermal insulation in the facades together with renewal of windows gets good results for heat energy savings but is very expensive also in long period. The most cost effective heat energy saving actions is different adjustment of HVAC solutions.

The rate of the original heat energy consumption effects on the rate can be achieved with repair measures or adjustments. In the cases with high consumption has been achieved higher savings than those buildings where the original level has been at lower rate in the beginning. Type of living e.g. occupant's use of water, use of shower and use of electricity etc. is crucial in total energy saving of buildings.

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