RETROFITTING POTENTIAL OF LARGE-SCALE PREFABRICATED BUILDINGS FROM PRE-“WENDE” TIMES: A CASE STUDY OF CROATIA

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INTRODUCTION

It is a widely known fact that buildings contribute largely to both worldwide GHG (green-house-gas) emissions and energy consumption. To change that, not only new buildings have to be designed following the principles of low- to zero-energy building, but also the building stock has to be addressed. In many European countries, an extensive stock of prefabricated buildings from pre-“Wende”-times (this means constructed prior to the fall of the Soviet Union) can be found, which particularly are of interest for large-scale retrofit measures. This is due to two major reasons: First of all, many of these prefabricated buildings were generated by industrial mass production of building components (e.g. wall-elements) and were several times combined in identical or rather similar fashion. Thus, retrofit measures can be designed in a feasible and easily applicable way, once the specific element has been subjected to a retrofit planning. The second reason is that such buildings often form the backbone of large residential communities, and as such cannot easily be replaced. Given the large extent of built volume and the poor thermal quality of such constructions, retrofit measures often seem to be more an urgent need than a luxury. This contribution focuses on a specific type of prefabricated houses in Croatia, known as building type JU-61, and on potential retrofit measures. The contribution is based on a recently written master thesis [1].

JU-61 (producer Jugomont) apartment blocks consist of modular units that form rooms with a floor plan size of 360 x 480 cm. To ensure the functional connections between the different units, a shift of connection walls by one third of the length or width of the system was considered. Figure 1 and 2 illustrate the building construction of a neighbourhood in Remetinečki gaj in (Novi-)Zagreb, and a typical two unit floor plan.

METHODOLOGY

A major challenge in retrofitting buildings is to balance the cost efficiency with the occupants’ thermal comfort levels and the technical legislation constraints. In a first step, a sample building of the buildings in Remetinečki gaj was selected. This building can be considered as representative of typical JU-61 buldings in size, volume, number of residential units, as well as regarding damages and current state. Figure 3 illustrates this building. The building features 5 floors, a total height of 16.8 m, all together 35 residential units, and a total gross building area of 2675 m² (net ara 1814 m²). The building spans from south to north, thus it’s major transparent components face east and west direction.

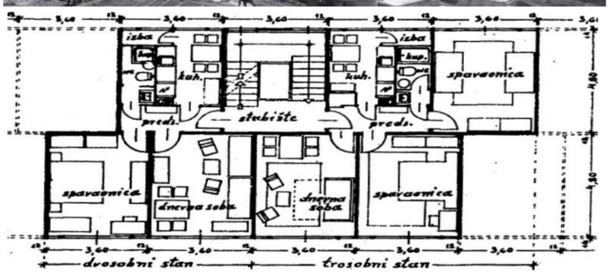

Figure 1 (top): Construction work in Remetinečki gaj in 1961 (private archive of architect Bogdan Budimirov)
Figure 2 (bottom): Typical Floor plan of JU-61

Figure 3: The case study building in today's shape.

Non-load-bearing opaque wall elements of the building are rear-ventilated panels, filled with a layer of mineral wool (4cm), an air gap, and – as a finishing – a corrugated metal plate. These metal panels provide inside why the buildings are also known as "tin-cans". Load-bearing elements are made of reinforced concrete (15cm), a thin insulation (4cm), and a similar corrugated metal plate. Today's condition of the building can be considered as bad. Beside from some private initiatives of individual occupants little to no maintenance work or refurbishment efforts have been undertaken in recent years. To assess the current energy performance and potential improvement scenarios, numeric simulation has been deployed, both on an overall building level [2], as well as on a thermal-bridge assessment scale [3]. Details regarding the input data assumptions and approximations made due to lack of data can be found in [1]. In addition to a base case scenarion that is based on today's condition, five different retrofit scenarios have been assessed. These encompass replacement of windows, increasing the insulation layers in the opaque elements, and the reconstruction of roof and floor constructions.

RESULTS AND DISCUSSION

For the base case, the simulation resulted in a heating demand of 136 $kWh.m^{-2}.a^{-1}$ and a cooling demand of 22 $kWh.m^{-2}.a^{-1}$. The different retrofit scenarios suggested heating demand reductions of 17 to 58% and cooling demand reductions of 5 to 33%. Regarding the amortization times of different retrofit scenarios, it can be said that all of the examined interventions pay off in between 12 and 17 years. In any of the suggested improvement scenarios, a careful detailing has to be conducted, given that the windows in their currently existing position do not show overlap/adjacencies with the insulation layers. This might become tricky in terms of thermal bridge / condensation risk aspects, if not considered properly.

CONCLUSION & FUTURE RESEARCH

The present study showed the potential of retrofit measures if applied to the "Tin Can" houses of Croatia (JU-61 prefabricated Jugomont residential builings). The saving potential is a considerable one, however, pay off times have to be considered carefully given the already long lifetime of these buildings. Furthermore, an ecological footprint comparison of the different retrofit scenarios still needs to be carried out.

REFERENCES

[1] M. Flegar: "Performance-based optimization potential of a widely used prefabricated building type: A case study of Zagreb"; Supervisor: A. Mahdavi, U. Pont; TU Wien2018; final examination: 2018-06-21.

[2] Department of Energy EnergyPlus, https://energyplus.net/

[3] AnTherm (www.antherm.eu)