Energy retrofit of tower blocks in UK: making the case for an integrated approach

Ornella Iuorio,
University of Leeds, School of civil engineering, Leeds, United Kingdom
o.iuorio@leeds.ac.uk

Abstract. Tower blocks in UK are at a critical stage. They were built at a time when no energy efficiency requirements were considered. They are now approaching the end of their design service life and they are damp, and cold place to live. Starting from the analysis about the diffusion of multi-storey buildings in EU, and the findings of other research projects such as INSPIRE and Faro, this work debates the strategies applied for energy efficiency improvement of large panel concrete buildings. This work debates the structural retrofit that in many cases are required prior to any energy retrofit intervention and draw the attention on the necessity to develop more holistic retrofit approaches, aiming to the development of best practice for energy, safety and social benefits.

Keywords: Energy efficiency, Fuel poverty, Multi-storey buildings, Retrofit

Introduction

The exponential grow of urban areas in both industrialized countries and in the Global South is responsible for depletion of natural resources and global warming. The built environment plays a key role on the triple bottom line of the sustainable development -Planet, People, Profit- and as such, the international community is promoting the development of a sustainable building market. In line with the 2020 European Strategy (United Nations, 2015) and the 2050 Roadmap, buildings energy efficiency is at the core of worldwide discussion about sustainable development and low-carbon economy. Thus, energy retrofit is a central to the discussion of architects and engineers, going from the building to the city scale.

In recent years, extensive exploration of retrofitting family buildings have been carried out. In the UK, the improvement of low-story buildings has been largely explored as testified by the New Barrack estate scheme and Kirklees Warm Zone scheme (Webber et al., 2015), or by the "Retrofit for the Future" programme, which outcomes are superbly synthesized in Marion Baeli book (Baeli, 2013). The 20 case studies exemplify pioneering approaches for a wide variety of UK construction typologies (solid masonry, cavity walls, timber frame). Fabric and heating, ventilation and air conditioning (HVAC) improvements are analysed. It clearly states "there is not a one size fits all approach" in retrofit, and it aims to build knowledge and confidence in the retrofit process. However, the retrofit of flats is not discussed. Sparse information about possible retrofit strategies and associated costs for intermediate flats is provided in (Gleeson, Yang and Lloyd, 2011), but no insights are provided for the retrofit of full tower blocks, consisting of many, interlinked flats. Multi-storey buildings have always had controversial fame, housing lower income people and offering poor comfort to the habitants. There has been a tendency of demolishing rather than converting them, with consequent strong environmental impacts. In an attempt to shift this trend the High-rise hope program (Lane, Power and Provan, 2014), led by the CASE centre, analysed energy efficiency measures and their social impacts on low-income areas, having as focus high-rise buildings. Its attention was on the £16.13 million regeneration project led by the London Borough of Hammersmith and Fulham (Fig. 1), aimed to transform the visual impact of Edward Woods at both estate and wider neighbourhood scale, while delivering energy consumption and costs reductions. The project involved extensive work on building fabric, communal areas, integration of renewables and the construction of 12 penthouses for private sale. It demonstrated that the benefits of improving energy efficiency go far beyond energy bill savings, having significant influence on human health, industrial productivity, fuel poverty alleviation and consequent national benefits. However, this scheme has been an extraordinary example, which certainly the recent tragic Grenfell tower event is shading. Since then, UK industry and policy are trying to quantify the scale of the problem. In order to discuss the challenge of improving energy efficiency and reducing fuel poverty across UK, this paper analyses the case of tower blocks in Leeds, and makes the case for a holistic retrofit approach, highlighting open questions in the final discussion section.

The case of Leeds, in West Yorkshire

The city of Leeds is the third largest city in the UK. It developed from a compact mediaeval market town and saw its first major expansion during the industrial revolution, retaining since then its industrial features. Leeds is now the centre of an urban area with a population of 2,454,000. Leeds housed a rising population after the two World Wars in high-rise buildings, known across UK as "Tower blocks". Today the city retains 116 apartment blocks (Fig. 2), higher than seven storeys, which were widely built between 1957 and 1972, and that constitute the 14% of Leeds City Council Housing stock. The towers house 8000 tenants and they are realized by twelve different construction typologies, which can be classified in twenty-two different thermal profiles. The tower blocks constitute for the council an important burden, for which the council is developing a 10 years investment plan from 2016 (Arup, 2016). The investment plan aims to achieve the ambitious objectives of reducing both carbon emissions by 40% and tenants energy bills by 10% between 2005 and 2020. These constructions are either in reinforced concrete frames, or constructed with a large concrete panel system. During previous energy efficiency campaign, some buildings have been improved through an extensive cavity wall insulation or an insulated cladding system. All these differences result in a wide variation of walls U-values that range from 0.34 to 1.56W/m^{2}K. Moreover, most of the heating infrastructure is outdated and in need of replacement.

The investment strategy developed by Arup for Leeds City Council defines five recommended interventions, providing at each intervention a scale of priority, ranging from 1 (high priority) to 4 (low priority). The priorities are as follows: priority 1, a) community heating system, b) new hot water cylinder; priority 2, c) new

ISSN online: 2239-0243 | © 2018 Firenze University Press | http://www.fupress.com/techne
DOI: 10.13128/Techne-22749

01 |

01 | Edward Woods Estate. London Borough of Hammersmith&Fulham (Photo O. Iuorio)

02 |

02 | Leeds tower blocks in their current conditions (Photo: O. Iuorio)

electric heater and controls; priority 3, d) cladding - external wall insulation; priority 4, increased roof insulation. The scenarios have been developed according to a cost effective invest-to-save strategy, based on a balance between carbon saving and reduction of energy bills.

The developed strategy looks at the towers as part of a complex city and defines community-heating clusters as a priority. What appears controversial is the poor importance given to retrofit of the building fabric. Indeed, although few have gone through previous insulation improvement, the resulting transmittance values are still far from the current UK target.

It appears clear that the strategy tends to shift the problem from fabric improvement to heating system updating. In such a way energy efficiency is surely obtained, but the requalification is approached by solving an episodic problem, rather than thinking to a long-term investment. Indeed, focusing exclusively on a single problem makes retrofit intervention limited to solving only part of the criticalities, without considering the complexity and the interrelation of all the deficiencies of the building system. Any retrofit solution conceived having in mind only one aspect is bound to failure in a long-term perspective. Certainly, interventions on mechanical and electrical systems maximize energy reduction for minimal investment. Nevertheless, an energy retrofit approach that focuses solely on equipment upgrades is 'effective but limited in the overall energy savings it can generate' (Griffin, 2016). An integrated renovation based on the envelope retrofit could instead have the potential to improve the energy performance, ensuring at the same time also other benefits related to the three dimension of sustainability (Iuorio and Romano, 2017). Energy retrofit of Leeds tower blocks should be considered as a driver of renovation at urban scale. Indeed these tower blocks are often located in deprived areas, where there is no interaction between the built environment and the urban context. In addition, they exhibit a high state of deterioration. As such, interventions on both the fabric and the structure could instead allow these buildings to improve the architectural quality and the structural safety (Romano, Iuorio, Nikitas and Negro, 2018), ensuring added property value, which can bring to a global urban regeneration.

Making the case for an integrated retrofit

Why energy retrofit of tower blocks are not considered in a more holistic perspective? Why inspection, safety and energy retrofit are not evaluated and carried out according a more coordinated effort? The tragic Grenfell tower event demonstrated the failure of an approach that looks only to one of this aspect. The verification campaign carried out to assess the quality of all the recladding interventions across UK, if from one side, for the first time, provides an overview about the extension of retrofit applications on multi-storey buildings, on the other side, demonstrates that those technical solutions have been adopted in many other buildings across UK. The verification campaign uncovers, indeed, a systemic problem.

However, a shift is possible looking at models across EU and UK that have demonstrated the feasibility of an integrated approach. In Italy, for instance, the project FARO «Innovation and sustainability of retrofit. Best practice for the retrofit and the maintenance» (Losasso, Pinto and Landolfo, 2013), identified best practices for the retrofit of existing buildings, as well as it highlights how a sustainable regeneration project requires an interdisciplinary methodological approach able to identify retrofit strategies capable to satisfy structural safety and energy requirements, as well as, been cost-effective and durable in a life time perspective. The project looked at the retrofit of buildings realized in the twentieth century. It highlights the importance of structural checks before the identification of any retrofit solutions, and demonstrates that cost-effective and sustainable solutions are the one that consider safety, energy, maintenance and costs at the same time. Case studies are used to articulate best practices. It demonstrates that often, the best solutions are the one that look at buildings starting from their use, considering the articulation of the spaces and functions within the building, and how they can be internally reorganized to make the best use of natural ventilation and solar radiations. Starting from the new distributions, the appropriate energy strategies are articulated. The project discusses the retrofit of the building fabrics in detail, and articulates the strategies in three main actions: substitution, subtraction and additions. Fig. 3, shows one of the proposed approach for the energy retrofit of a multi–storey reinforced concrete building in Mercogliano, in South of Italy, built in the ‘80s. The case demonstrates how starting from an internal redistribution of the functions, the energy retrofit can be achieved through the adoption of a double skins on the south side, that integrates the vertical and horizontal distribution systems with stairs and corridors together with the technical elements of the buffer zone made of insulation, air ventilation and shading systems. Moreover, the proposal also looks at how the economic investment could be repaid by the extension of the building with an extra floor. All the solutions envisaged for the double façade and the roof extension make use of prefabricated technology based on cold formed steel profiles, that being a light and dry technology (Iuorio, 2007), allows new functions to be integrated in the existing building without a substantial increment of loads and, allowing also to reach transmittance values for walls and roof compatible with those required today for new constructions. Moreover, industrialized prefabrication technologies can offer a better quality of workmanship and a faster construction process. The use of prefabricated systems present several sustainable advantages such as optimized constructions quality and flexible systems, cost efficiency due to prefabrication, a quick renewal process with minimized disturbances for the inhabitants, a dry construction process, an easy maintenance for planned and/or repair interventions and the potential reuse of elements at the end of the life-cycle (Iuorio, Fiorino and Landolfo, 2014).

03 |

03 | The Mercogliano case study: before and after retrofit intervention. "Faro" research project. (Photo: M. Mucciardi)

Similarly, the more recent European project INSPIRE (Ciutina, Ungureanu, Grecea and Dubina, 2013) developed integrated strategies and policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions. It looks specifically to four European countries: Denmark, Romania, Sweden and Switzerland. The project aimed at: a) assess energy efficient building retrofit strategies according to a techno-economic lens; b) assess the actors and policy instruments for energy efficient renovations; and 3) it looked at case studies of sustainable renovation.

Interestingly, one of the case studies of the INSPIRE project is a large panel concrete multi-storey building. Clearly, this case study is investigated because they represent a large share of the existing building stock in all the investigated countries. The project identifies packages of solutions that combine building fabric interventions with energy renewable technologies, district heating systems, heat pumps and more. In the assessment of the actors, policy instruments and in the economic analysis (Nagy, Fulop and Talja, 2013), the return of the investment is discussed, and one key methods that allows to achieve the return of the investment is the addition of technical elements, as balcony or building extensions, that are capable of improving the property value. Moreover, the authors have also looked at how the proposed energy retrofit solutions should go hand in hand with structural retrofit solutions, that should allow to improve the resilience of those buildings if subjected to earthquakes and/or explosion. These last are indeed key issues that national and local governments should tackle with the same effort of increasing energy efficiency and reducing fuel poverty.

Conclusion

This paper discusses the importance of looking at energy efficiency of multi-storey buildings in a more holistic way. The tragic Grenfell Tower event, that in June 2017, caused the a death tall of 71 people and many more injured, following a fire explosion in London, has brought the public attention to reflect on the approach used for the improvement of energy efficiency of multi-storey buildings. However, the building under discussion also belongs to the same typology of buildings that in 1968 were subjected to the Ronan Point collapse (Currie, Reeves and Moore, 1987), when a gas explosion blew out load bearing walls of a 21 storey tower, causing the collapse of an entire corner of the building. Time passed and many towers are still at risk of blast explosion. This paper raises the question: when will retrofit interventions start to be conceived in an integrated way? Is not the time of making the safety and the wellbeing of the occupants at the centre of the investments? Studies demonstrate the benefit that a more coordinated approach could have in terms of social benefits and industrial productivity. Building efficiency should be regarded as a mechanism capable to unlock social criticalities that are connected to technical problems. Improving energy efficiency of existing buildings should be regarded as a way to enhance local competitiveness through energy productivity, and strengthen city's economic and climate resilience.

REFERENCES

Arup (2016), *Energy efficiency study for high-rise flats*, Investment Strategy Report, REP/1/Strategy, Leeds City Council, Leeds, UK.

Baeli, M. (2013), Residential retrofit 20 case studies, RIBA Publishing, London, UK.

Ciutina, A., Ungureanu, V., Grecea, D. and Dubina, D. (2013), "Sustainable thermal retrofitting solutions for multi-storey residential buildings", in Ungureanu, V. and Fülöp, L. (Eds.), *Romanian-Finnish seminar on Opportunities in Sustainably retrofitting the large panel reinforced concrete building stock*, Orizonturi Universitare, Timisoara, HU, pp. 97-112.

Currie, R. J., Reeves, B. and Moore, J. (1987), *The structural adequacy and durability of large panel system dwellings - Part 1: Investigations of construction; Part 2: Guidance on appraisal*, Building Research Establishment Report (107), IHS BRE Press, Bracknell, UK.

Gleeson, C., Yang, J. and Lloyd-Jones, T. (2011), *European Retrofit Network: Retrofitting Evaluation Methodology Report*, University of Westminster, Westminster, UK.

Griffin, C. (2016), "Multi performance retrofits to existing buildings: increasing resiliency and reducing the environmental impact of buildings trough simultaneous structural and energy retrofits", Proceedings of CERI2016 Conference, pp. 7-13.

Iuorio, O. (2007), "Cold-formed steel housing", *Pollack Period*, Vol. 2, pp. 97-108.

Iuorio, O., Fiorino, L. and Landolfo, R. (2014), "Testing CFS structures: The new school BFS in Naples", *Thin-walled structures*, Vol. 84, pp. 275-288.

Iuorio, O. and Romano, E. (2017), *Energy retrofit approach towards a multi-performance renovation of existing buildings,* Proceedings of the SEEDS Conference 2017.

Lane, L., Power, A. and Provan, B. (2014), *High-rise hope revisited. The social implications of upgrading large estates*, CASE report 85, Rockwool.

Losasso, M., Pinto, M. R. and Landolfo, R. (2013), *Innovazione e sostenibilità negli interventi di riqualificazione edilizia. Best practice per il retrofit e la manutenzione*, Alinea, Florence.

Nagy, Z., Fülöp, L.A. and Talja, A. (2013), "Are we too capitalists for a comfortable life? Business models for future and existing flat building administration", in Ungureanu, V. and Fülöp, L. (Eds.), *Romanian-Finnish seminar on Opportunities in Sustainably retrofitting the large panel reinforced concrete building stock*, Orizonturi Universitare, Timisoara, HU, pp. 117-130.

Romano, E., Iuorio, O., Nikitas, N. and Negro, P. (2018), *A review of retrofit strategies for Large Panel System buildings,* Proceedings of The Sixth International Symposium on Life-Cycle Civil Engineering.

United Nations (2015), *Transforming our world: the 2030 Agenda for Sustainable Development*.

Webber, P., Gouldson, A. and Kerr, N. (2015), "The impacts of household retrofit and domestic energy efficiency schemes", *Energy Policy*, Vol. 84, pp 35-43.