EnerPHit for Social Apartments: Marrying old and new

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1 Introduction

The building in question is a home for the elderly, comprising 34 apartments owned by Dún Laoghaire Rathdown County Council (DLR Co. Co.). The Architecture and Culture Department of this County Council are the designers of this refurbishment project. MosArt architects are the EnerPHit consultants. This refurbishment project is one of the several EnerPHit projects involved in the EuroPHit European project. On the EuroPHit website (europhit.eu) more detailed information about this and other projects is available. This building was chosen as it wasn't achieving the minimum comfort levels deemed acceptable for the residents.

The original two-storey building comprised 1960's pre-cast wall units as well as poured concrete interior walls, floors and roof. The external walls are pre-cast concrete panels with pebble-dash finish (Figure 1). This building has small to moderate size window openings and relatively low floor to ceiling height, so creating the main Passive House component challenge – the ventilation strategy and its air ducting runs and sizes. Ventilation was mostly natural, using opening window sections but also some room-based fans. The building is on an east-west axis in terms of solar gains with heavy shading to the north-west and quite open to the south-east. The central oil-burning boiler located on the roof was the space and water heating source.

Figure 1: Left: North-west original view (MosArt 2013). Right: North-west current view (MosArt 2015)

The proposed development comprises the addition of another whole floor on top of the existing building as well as minor extensions to accommodate vertical circulation. Due to increased accommodation area for each apartment, the resulting number of apartments will remain at 34. The retrofitting of the existing structure involves external wall insulation and Passive House-certified windows as well as the new top level, comprising walls of aerated concrete block with external insulation and lightweight metal deck roof. A mechanical ventilation heat recovery (MVHR) unit will be installed in each apartment as well as for each community area and circulation areas. A central micro CHP (combined heat and power) unit with gas condenser boiler will be the source of heat for all radiators installed throughout the building. This CHP unit will also be the source of heat for the domestic hot water.

2 Passive House Training

As part of the EuroPHit project, training was delivered to both designers and contractors involved in this project. Training was delivered by MosArt in conjunction with the Passive House Academy in Ireland.

A Certified Passive House Consultant course was delivered to the design team in charge of this project. A Passive House Tradesperson course was delivered, involving both theory and practical training. Most interestingly, these two aspects of the latter course were taken by different members of the construction team, something that emerged as a problematic split in understanding on the part of those working on site: Those who had taken the 3-day theoretical part were not those who undertook the 2-day practical part, yet it was the latter who were intended to site-manage the project. Their lack of theoretical background showed on more than one occasion, for example, when agreeing on a particular window in respect of it number of seals, whether one, two or three (Figure 2).

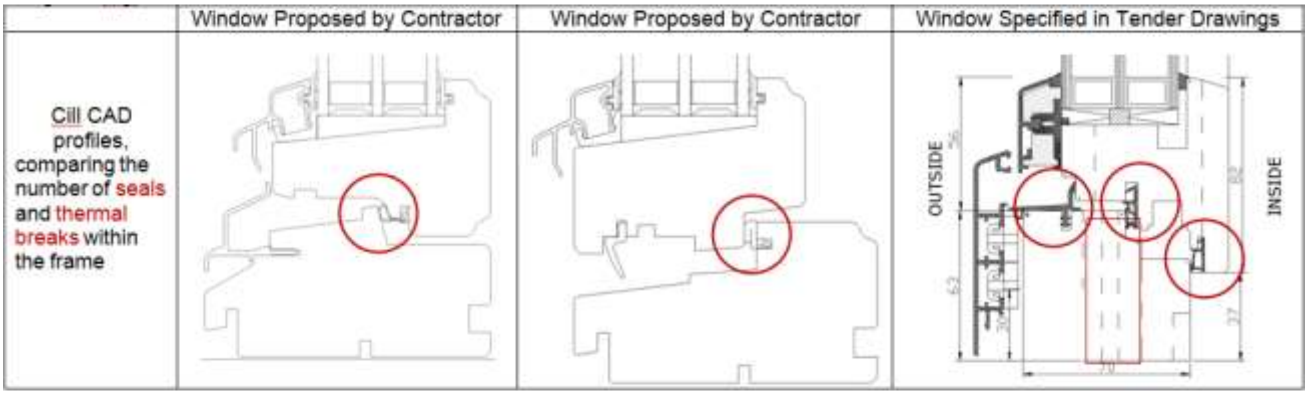

Figure 2: Window profile comparison table (MosArt 2015)

As part of the EuroPHit project, MosArt developed and delivered a 3-day Airtightness Install and Measurement course which, in particular, covered aspects of step-by-step refurbishment projects. It was well attended by different members of both the design and construction teams of this project.

3 Design Stage vs. Construction Stage

MosArt acted as a consultant for Dun Laoghaire Rathdown County Council architects throughout the design stage and was advising at both tender and construction stages. The architects were well practiced with respect to conventional construction and were eager to enhance their knowledge to reflect the Passive House approach. At the design stage, it was inevitable that certain assumptions would be made as it simply was not feasible to expose all elements in order to facilitate design. Despite the best of intentions, the reality of certain construction conditions as revealed during the construction phase necessitated a re-thinking of the refurbishment approach.

3.1 External insulation and foundations

One of these situations concerned the foundations. It is normal in retrofit work involving external insulation (Figure 3) to maximise continuity of insulation in order to mitigate thermal bridging at the junction of rising wall and floor. Accordingly, the design drawings and specifications showed not only the continuation of insulation down from the external walls to the top of the strip foundation, but also across the strip and down its outer edge. This will minimise heat loss through the existing floor slab that will remain uninsulated (Figure 3, right).

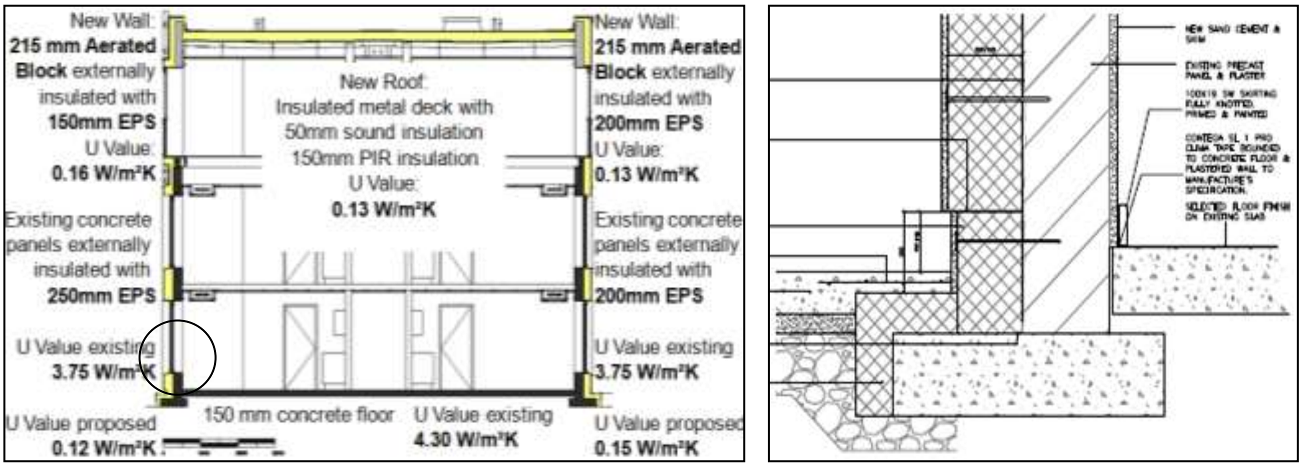

Figure 3: Left: Typical section showing two lower existing floors with new second floor above and the proposed external insulation on existing walls and new walls, indicating U-values of existing and proposed EnerPHit development (MosArt 2015) (not to scale). Right: Existing foundation detail showing the proposed external insulation on existing external walls down to the foundation and wrapping down to the edge of the foundation foot (Source: DLR Co. Co.) (not to scale)

The reality on site once the foundations were uncovered, however, precluded the implementation of the majority of this design. In hindsight, one might have suspected, based on normal site practice, uneven foundation strips both along their edge and on top. The latter condition posed the possibility of levelling this surface to avoid gaps between the concrete and insulation, but this would increase costs. This, in turn, prompted a thermal analysis to determine the minimum height between floor level and foundation top to ensure an adequate internal surface temperature. This was discovered to be 290 mm which happily coincided with the existing dimensions. Subsequently it was discovered that the dimension available was even greater over certain lengths.
This height of 290 mm, given the kind and thickness of insulation involved, ensured a minimum surface temperature of 15 °C (Figure 4), a requirement for mould avoidance of the Technical Guidance Documents as part of the Irish Building Regulations. So, whilst within the Passive House framework, lower surface temperatures are possible, one must still conform to the national requirements.

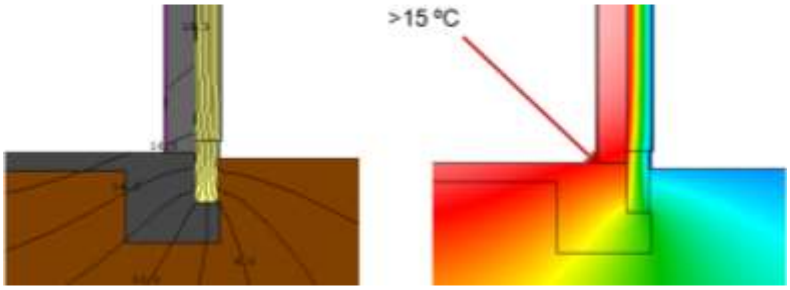

Figure 4: Refurbished existing foundation thermal bridge analysis using Therm software (not to scale)

3.2 External wall and airtightness

Another situation of non-concurrence between design and site conditions pertained to how the external wall was to be used as part of the airtight layer. The fact that the existing walls comprised poured concrete and had already proven relatively airtight led to an assumption that their inner surface could function as the airtight layer (Figure 5). The latter would be made continuous between floors by virtue of the assumed homogeneity of existing poured concrete elements. This would be assisted by taping over the lower portion of the ground floor and upper part of the first floor. This would, however, necessitate taping not only along the junctions with the external walls, but also along the contiguous internal partition walls due to the possibility of these walls acting as conduits for air movement. Notwithstanding the assumption of homogeneity cited above, the process of demolishing unrequired internal partitions rendered clearly that no reliance could be maintained on any aspect of the interior in order to achieve airtightness. The time and skills input required for taping all floors to walls, either internal or external, rendered this approach economically unrealistic.

It was thus decided to switch from the inside surface to the outside of the existing fabric (Figure 5). This would allow for the bypassing of all of those internal partition and floor junctions with the external walls. The main concerns here, therefore, would be with achieving airtightness along all precast concrete panel junctions, along the interface of these panels and the ground floor plinth and along the existing parapet in preparation for continuity with the airtight layer on the new top floor. In terms of workmanship and time, this alternative would prove less risky, time saving and easier to manage.

With the above switch from interior to exterior, it was assumed that the airtight layer for the new top floor would remain as designed, on the interior. Upon reflection, the difficulties became apparent. Firstly, the returning from the exterior of an airtight membrane to the inside of the new level might not be straightforward. Secondly, the maintaining of the airtight layer on the inside could prove a challenge, given the number of loadbearing cross walls involving blockwork keyed into the external wall. The concept of complete mortaring of all blocks involved is fine in theory but unlikely in practice.

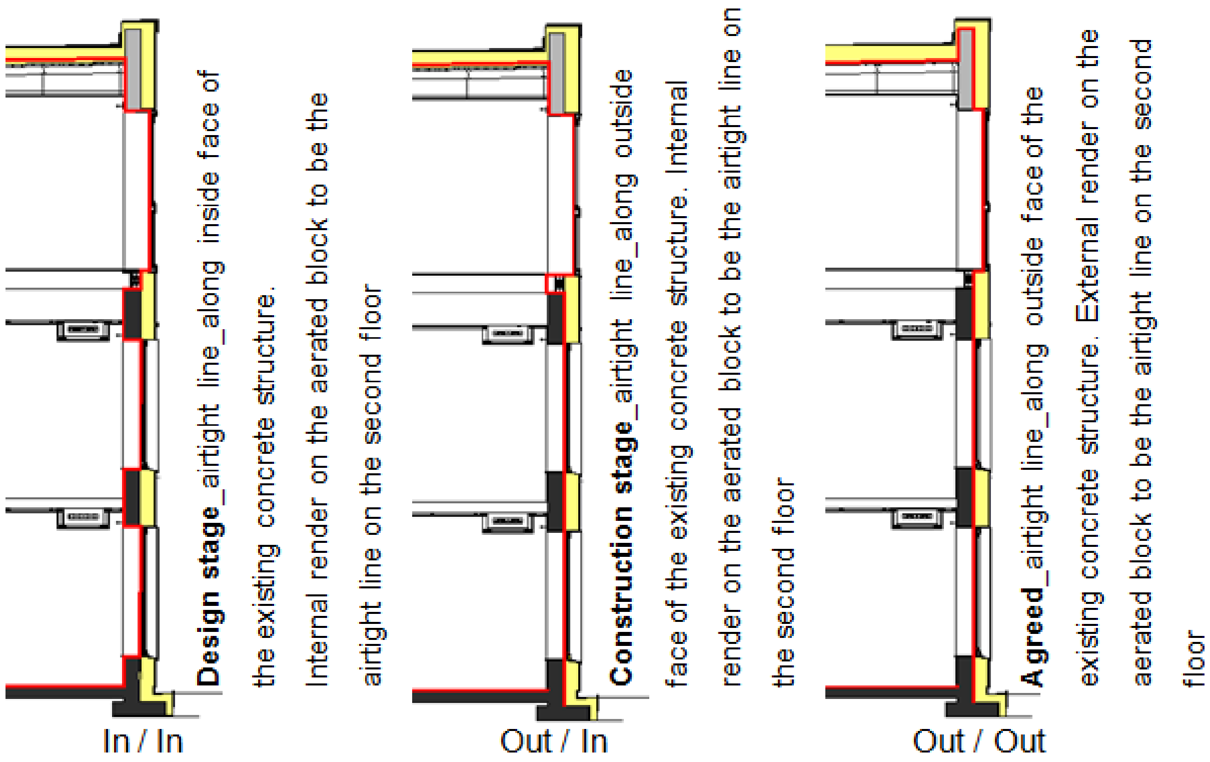

Figure 5: Typical section showing airtight line journey (not to scale)

Accordingly, it was decided to create the airtight layer on the exterior of the new top floor (Figure 5). Whilst it is not normal to externally render a new masonry wall before applying external insulation, this is exactly what was required to realise the airtight layer.

4 Mechanical Ventilation: a journey of discovery

Identification of the most acceptable mechanical ventilation system involved the entire design team. Significant concerns included heat recovery efficiency, dimensional limitations, fire protection, increased structural requirements, access, cost and the process of management in respect of general maintenance and emergency shutdowns. Systems considered included a broad range of possibilities, such as a single centralised unit for the entire building, grouped systems and a single unit per apartment. Perhaps the greatest single constraint was the very limited floor-to-ceiling height of 2.4 m that effectively precluded ducting of any significant size. The following are the MVHR systems considered.

1. <u>Individual unit per apartment</u>: These would comprise a small ceiling-mounted unit in each apartment, located in a locked plant room accessed only by the Local Authority maintenance staff. The advantages were: avoidance of large centralised ducting and increased efficiency. The disadvantages were: initial increased overall MVHR capital costs, involving 34 individual units, significant number of filter pairs as well as the associated servicing and maintenance demands.

2. <u>Centralised unit(s)</u>: In this instance, a single unit was to be mounted on the roof in a new plant room, and primary duct trunks were to run along the centre of the building

with drops on either side of the corridor serving six apartments, i.e. a pair of apartments per floor. An alternative to this would be a series of four units mounted at regular intervals along the building, each serving two apartments per floor. The advantages were: low capital cost and simplest process of maintenance with only one/four machine(s) concerned. The disadvantages were: reduced efficiency, significant change in building profile from what had been granted planning permission, effectively involving massive plant rooms above part of the new roof, additional stairs access and additional safety and arrest equipment to safeguard maintenance staff, increased floor load necessitating a switch from the intended lightweight metal roof to concrete and, so, increased costs. A plethora of fire dampers were required for fire separation between apartments and common areas which would result in excessive capital and maintenance costs.

Option 1 was chosen as it proved to be the cheapest whilst keeping the heat recovery efficiency at required high levels.

5 Lessons Learnt and Conclusion

Retrofitting of social housing apartments to the EnerPHit Standard as part of the EU-funded EuroPHit project is challenging, but becomes particularly complex where an entirely new floor is required to Passive House Standard. Connections between the old building, to be refurbished to EnerPHit Standard, and a new second floor above it were detailed to minimise any thermal bridge and any airtight layer gaps. Thermal bridging was greatly minimised as external insulation was the norm throughout the building fabric of this project. A key concern was the airtight level required to achieve the standard and how the airtight layer must be detailed, having in mind both its application, feasibility in relation to existing and possible damaged building fabric, and its continuity, in particular between old and new building fabric.

The following are lessons learnt from this EnerPHit project:

- Tender documentation must specify required window frame and glass U-values, number of seals in frame for both airtightness and frame surface temperature. Tender must also require comprehensive Passive House training for tradespersons as it is critically important the grasping the *why* and the *how* of construction.
- The process of air pressurisation testing of an existing building should include an air leakage detection analysis as part of a thorough analysis of an existing building fabric, for an accurate and more realistic airtightness strategy at the design/planning stage.
- Programme in preliminary pressurisation test(s) for the entire building. The Contractor must be made aware that temporary sealing might be required in order to carry out preliminary testing properly. This can prove a challenge as all parts of a building might not be at the same stage.

Summary

Retrofitting of social housing apartments to the EnerPHit Standard as part of the EU-funded EuroPHit project is challenging, but becomes particularly complex where an entirely new floor is required. This is what the Dún Laoghaire-Rathdown County Council, Ireland, required for Rochestown House.