Alternative ducting options for balanced mechanical ventilation systems in multifamily housing

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SUMMARY

Duct routing often poses a great challenge when planning the installation of a mechanical ventilation system with heat recovery. This is particularly true for retrofits, where the necessary space for supply and exhaust ducts was originally not accounted for. This extended summary presents an alternative approach for duct routing avoiding ducts in the dwelling, while allowing the installation of a centralized MVHR unit and the implementation of a cascading airflow through the dwelling. The general advantages as well as some implementation details within a refurbishment case study are presented.

KEYWORDS

Mechanical ventilation, heat recovery, duct routing, external insulation, insulation integrated ducting

1 INTRODUCTION

Duct routing often poses a great challenge when planning the installation of a mechanical ventilation system with heat recovery (MVHR). This is particularly true for retrofits, where the necessary space for supply and exhaust ducts was originally not accounted for. If the floor plan as well as the room height allows, a false ceiling can be installed in the hallway and/or the bathroom of the apartment enabling the installation of the ducts, the silencers and the flow control valves (in case of a centralized system) or the MVHR unit for the apartment. However, in practice this solution is often difficult to implement, resulting in a cost intensive installation and operation, e.g. due to the need to install many fire dampers and suspended ceilings. In fact, spatial requirements and duct routing has been identified as one of the barriers for widespread implementation of MVHR in various countries (Bocanegra-Yanez et al. 2017). As a consequence, many housing refurbishment projects opt for the installation of an exhaust air system (if space for the exhaust ducting exists), giving away the potential for substantial energy savings by heat recovery. Alternatively, the use of room-based decentralized ventilation unit with heat recovery are used. However, room-based systems result in lower ventilation efficiency, since the air cannot be cascaded from supply to extract air rooms, requiring nearly twice the total air exchange. In general, these solutions often fall short also in terms of thermal or acoustic comfort as compared to a cascading MVHR system due to sound emission of the units and reduction of sound insulation of the exterior walls by multiple wall openings. They also lack the possibility to install good air filters.
The herein presented approach avoids ducting within the dwelling, while allowing the installation of a centralized MVHR unit and the implementation of a cascading airflow through the dwelling. It has been applied in several refurbishment projects within the FP7-project “Sinfonia”, see (Music 2018) and https://passivehouse-database.org under the project ID 5673, 5674, 5675 and 5676.

2 RESULTS

The principal idea of this ducting solution is simple: install the central ventilation unit in the attic and run the supply and extract air ducts down into each apartment and each room on the outside of the external walls through the insulation layer (see Figure 1). This approach requires a core hole (or a window integrated opening) in each room where air is supplied or extracted. However, it has several advantages. The major advantage being that duct routing within the apartments can be avoided. The other advantage is related to necessary fire protection measures. When ducts are routed through the interior of the building, fire safety codes in Austria (and other countries) prescribe the installation of fire dampers and/or other fire protection measures, whenever the ducting penetrates walls of declared fire zones. Such dampers are costly and need regular inspection. Their easy accessibility often poses a major issue for property managers, if they are installed in the false ceiling within the flat. In the presented case study the number of required fire dampers could be greatly reduced with all of them being easy accessible in the attic of the building. The MVHR unit was placed within a fire protected housing only needing four (easy accessible) fire dampers at its penetration points, see Figure 2 (left). From there, the supply and extract air ducts are split and routed to the exterior wall. After the splitting, manual flow valves and silencers were installed, see Figure 2 (right).

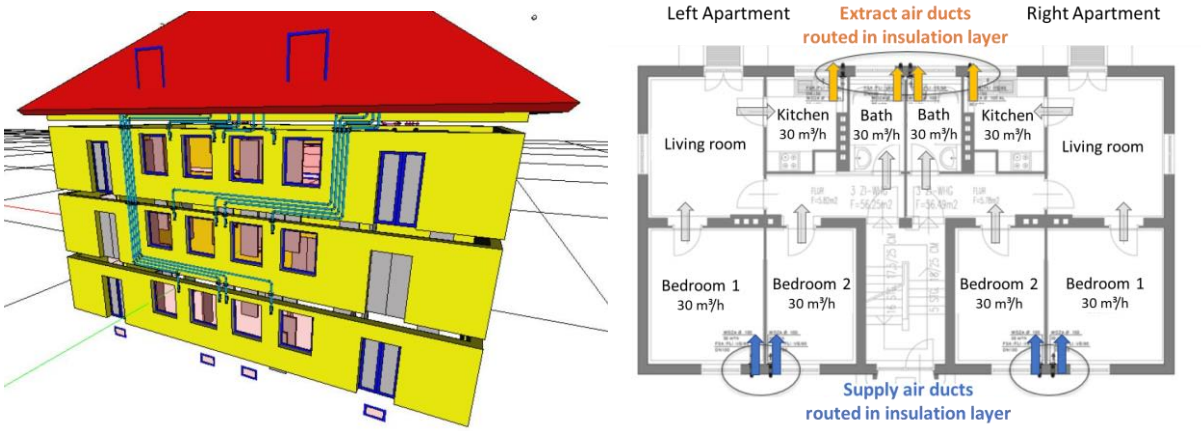

Figure 1: Left: 3D sketch of one of the case studies installing the supply and extract air ducts in the exterior wall insulation. Source: (Music 2018). Right: Floor plan of the case study where all supply and extract air ducts are integrated in the external wall insulation. Note that the living rooms are ventilated with overflowing air (extended cascade principle).

All together, this ducting solution simplifies centralized MVHR systems, which are generally considered advantageous in terms of maintenance/accessibility for non-owner occupied housing. To fully exploit the advantages of this approach all bedrooms and wet rooms should have access to an exterior wall where ducts can be integrated. Nevertheless, this concept was also advantageously applied in projects by combining external and internal duct routing, see (Music 2018). Ideally, the supply air rooms are on one side and the extract air rooms on the other side, e.g. see Figure 1. In the presented case studies the 7 cm diameter ducts were installed within the existing cork insulation layer (6 cm). They were covered by the new 20 cm thick EPS insulation layer. However, an existing insulation layer is not a prerequisite, since the slots for the ducts could also be included within the new insulation layer. Basic calculations suggest the remaining insulation thickness should be roughly >2/3 of the total insulation layer to avoid significant heat losses. Other projects investigated the use of pre-formed EPS elements to ease the integration of air ducts in the insulation layer (Hauser and Kaiser 2013; Schwerdtfeger 2018).

Figure 2: Left: *Central unit with fire protected housing and fire dampers at the top. The fire protected maintenance cover at the front is not mounted in the picture. Right: Supply air ducts in attic with flow regulation dampers, silencers and penetration to the outside of the exterior wall.*

3 CONCLUSIONS AND OUTLOOK

This case study presents an attractive alternative for routing the supply air and extract air ducts for centralized MVHR during a deep energy retrofit of multifamily housing. The main advantage is the fact that no ducting is needed within the dwelling, thus saving space and minimizing disturbance of dwelling occupants. The layout of these case study buildings allowed a very simple planning, in particular in terms of fire protection, and resulted in a smooth installation process. Due to it simple and low tech design (manual flow regulation valves, few fire dampers, no false ceilings, etc.) the costs could be kept at roughly €2500 per apartment, which less than half of the costs for installing the MVHR system in comparable projects. As it worked well for deep retrofit, this concept could also be adapted for new buildings as well. Up to now, it was only applied for centralized MVHR. The University of Innsbruck is currently investigating a decentralized concept (one unit per dwelling), further reducing necessary fire protection measures.

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