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PREFABRICATED INTERIOR FAÇADE SYSTEM WITH VACUUM INSULATION PANELS AND AN ADVANCED DIGITAL WORKFLOW FOR DEEP ENERGY RENOVATION: A CASE STUDY IN SPANISH SOCIAL HOUSING

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Abstract – The energy efficiency retrofitting of the building stock is a current effort in most European countries. Most interventions in the building envelope are carried out by adding external insulation to the façade, which modifies its composition and materiality, altering the urban landscape and contributing to a progressive loss of architectural identity. Internal insulation façade systems are less common and mainly used in high-value heritage buildings, where the main disadvantage is usually associated with the loss of internal space. However, new high-performance and thin insulation materials have appeared on the market, making their application feasible in common buildings such as social housing. This paper presents the design of a prefabricated interior façade system based on a timber frame and Vacuum Insulation Panels (VIP), incorporating space for service routing. The system can vary from 75 mm to 90 mm depending on the building's energy requirements. A comparison of interior surface loss for different business-as-usual solutions was carried out to demonstrate the reduction in insulation thickness provided by VIP panels. To develop the prefabricated façade solution, advanced digitalised processes were implemented to link the laser-scanning of the existing building, which was used to generate the BIM model, with the industrial manufacturing of the system, addressing the limitations of VIPs for onsite work. The façade system has been tested and validated in 12 social housing units in Northern Spain. The proposed solution achieves a 43.9 % reduction in surface loss compared to the business-as-usual scenario and a 36.0 % reduction relative to the high-end alternative. The optimised workflow redistributes effort from installation to earlier manufacturing phases, yet no immediate economic advantage was observed due to limited knowledge of digitalised processes; however, the approach still offers long-term potential in optimisation, waste reduction, energy savings, and assembly efficiency, providing valuable lessons for future deep renovation strategies.

Keywords – Digitalised construction workflows; interior insulation systems; social housing renovation; vacuum insulation panels

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