Performance evaluation of external vacuum insulation finishing system

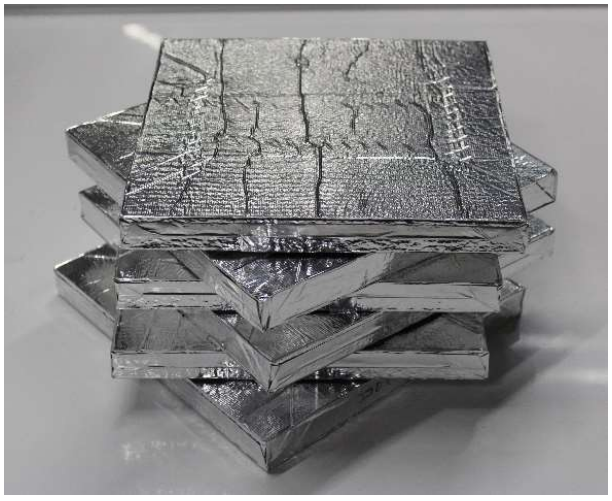
Summary

As building energy performance requirements continue to become stricter in order to fit in with nearly zero-energy buildings targets, there is an increasing demand for higher insulation levels. This has motivated the development of innovative solutions that incorporate super-insulating materials and products. Among these are solutions that incorporate vacuum technology. A vacuum insulation panel (VIP) is a top-of-the-line product characterized by having extremely low thermal conductivity, meaning it has potential to provide a great insulation level at a reduced thickness. Since the External Thermal Insulation Composite System (ETICS) is one of the most popular construction technologies used for improving the energy efficiency of building walls, there is interest in combining the high thermal performance of VIPs with the known benefits of ETICS. However, in spite of showing strong potential in terms of thermal performance, the application of vacuum insulation panels in buildings presents several challenges that must be account for. Namely, those associated with design factors, handling and installation issues, as well as with the edge thermal bridging that occurs between panels, the doubts surrounding service life performance and, finally, the high investment costs of VIPs. Furthermore, there are several known anomalies that commonly occur in conventional ETICS and which could be exacerbated with VIPs. Hence, many aspects need to be carefully evaluated before VIP based ETICS become a viable solution for meeting energy targets.

The main goal of this research was to study the feasibility of incorporating a novel VIP solution into external thermal insulation composite systems. For this purpose, a comprehensive investigation into the solution was carried out. Laboratorial tests were performed to assess the effective behaviour of the solution in terms of physical, mechanical and hygrothermal performance. First, focus was put on the VIP product, in particular regarding the edge thermal bridging effect. Then, VIP based ETICS walls were evaluated in terms of the whole system hygrothermal performance and durability. Real onsite walls and laboratorial large-scale test specimens were assessed. New experimental procedures were defined to evaluate the durability of the solution and to enable the early identification of potential anomalies. Additionally, numerical models were used to simulate the steady and unsteady thermal behaviour of VIP products and their accuracy was evaluated against the experimental results. Finally, the cost-effectiveness of vacuum technology was also analysed by means of a whole-life cost assessment. Throughout the research, the evaluation of VIP based ETICS walls was often compared with other conventional solutions (used as a reference).

Keywords

Vacuum insulation panels, ETICS, hygrothermal behaviour, experimental testing, onsite monitoring, numerical modelling, whole-life cost assessment.



Samples of vacuum insulation panels.

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