Impact of implementation conditions on the durability

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FOREWORD

The content presented comes from the VIP (Ventilation Information Paper) "Durability of building airtightness" that will soon be published on the Airbase, the AIVC bibliographic database.

KEYWORDS

Airtightness, durability, implementation conditions, workmanship, literature review

1 WORKMANSHIP – HUMAN IMPACT

- **Workmanship quality and reproducibility**

In Netherlands Colijn et al. (Colijn et al., 2017) have shown the influence of workmanship quality on the airtightness of dwellings. They noted differences in performance among building crews for 44 similar detached houses. The application of minor technical solutions and educational sessions allowed to reduce the specific air leakage rate by 27% on 14 houses.
In Czech Republic the analysis of 558 tests on newly built houses between 2006 and 2019 showed large differences in airtightness performance for identical types of houses built with the same technology and by the same construction company (Böhm et al., 2021). The authors concluded that the most important parameter influencing the resulting airtightness values was the control of the implementation of individual building details during the construction of a building.
Some studies at a smaller scale focus on the impact of workmanship on the airtightness performance of specific construction details. For example, in Norway Relander et al. have studied the influence of widely used lightweight aggregate concrete element chimneys on the airtightness level of houses (Relander et al., 2010). They pointed out that the airtightness provided by the surface treatment was very sensitive to the workmanship and that a thorough workmanship could make this influence negligible.
Van Linden and Van Den Bossche (Van Linden and Van Den Bossche, 2020) have tested 18 sealing materials and attest that faulty workmanship has a significantly greater impact on the material performance than artificial ageing.
Concerning building joints submitted to external environment, Nečasová et al. (Nečasová et al., 2017) also noted the necessity to verify the compatibility of materials and to follow the recommendations since "in most tested cases, diversion from the above-given steps resulted in failure of the sealed joint".

- **Last minute corrections**

Concerning the airtightness test phase, last-minute corrections can also impact the airtightness durability. Wingfield et al. (Wingfield et al., 2008) have pointed out that secondary sealing

may have benefits in the short-term to pass the airtightness test but is prone to degradation over a relatively short time and is therefore not a robust long-term solution.

2 IMPLEMENTATION CONDITIONS – ENVIRONMENTAL IMPACT

The impact of implementation conditions on the airtightness performance has not been much experimentally studied yet. One interesting study on this topic was carried out by Antonsson and Emanuelsson (Antonsson and Emanuelsson, 2018). They studied the durability of three airtightness systems with air permeability measurements before and after artificial ageing for three implementation conditions:

- Ideal conditions: normal indoor laboratory climate
- Cold and humid environment: about 5°C and 90-95% RH on both sides of the wall
- Dusty conditions: artificial dust (made of crushed concrete sieved to a grain size of max. 0.063 mm, gypsum and wood sawdust) sprayed against the plastic foil

The results showed that, depending on the set of products used for the wall sealing, the implementation conditions can more or less impact both the initial airtightness level and its durability.
About sealing implementation on dusty conditions, in their above mentioned study Wingfield et al. (Wingfield et al., 2008) observed on-site that dust prior to application was often the reason behind the adhesive failure of the sealant.
Fufa et al. (Fufa et al., 2018) have also underlined the necessity of having a surface dry, free from dust and grease for the adhesion performance, with the necessity of a good adequation between the intended and actual tape use, and a special treatment of the substrate when required.

3 AIRTIGHTNESS TESTS REPRODUCIBILITY AND REPEATABILITY – HUMAN AND ENVIRONMENTAL IMPACT

The reproducibility and repeatability of airtightness pressurization tests was investigated by Bracke et al. (Bracke et al., 2016) in extremely airtight houses, showing that the human factor impacts the test results even if the same protocol is followed.
Concerning the reproducibility, with special attention to airtightness they could obtain a variance coefficient of 12% on 15 quasi-identical houses, which is much lower than the 28% of a previous similar study on 29 houses with no special attention to airtightness (Laverge et al., 2014).
To investigate the repeatability issue on the pressurization test, 2 houses were tested up to 10 times a day, on respectively 7 and 6 different days. On average, the measurements showed a standard deviation of respectively 1.1% and 2.7% and a maximum variation within the same day of respectively 3.5% and 7.7% which is in agreement with other literature results.
Additional tests were performed to evaluate the impact of small preparation details such as locking doors (without neglecting standard EN 13829) and it was concluded that apparently small decisions can be determining for passing the test for passive houses.
This underlines the necessity of having the same operator testing all houses when studying other aspects such as the airtightness durability.

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