Lessons learnt from the state of the art of airtightness durability: laboratory measurements

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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.

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Airtightness, durability, laboratory measurements, literature review

1 KEY POINTS FOR LABORATORY AIRTIGHTNESS DURABILITY ASSESSMENT

A literature review of 13 laboratory studies from 8 countries is presented, with the performance of sealing products and/or assemblies tested before and after artificial ageing. The results differ from one study to another. One of the reasons may be that the protocol is not standardised. Nevertheless, the following general conclusions can be drawn (Langmans et al., 2015; Michaux et al., 2014; Ylmén et al., 2014) :

- **The airtightness durability depends on many factors and further research are needed to better define each impact**: product selection (Antonsson, 2015); compatibility problems between products (Ylmén et al., 2014); implementation conditions including both the workmanship and the environmental conditions; type of loads
- **Importance of testing the durability of wall assemblies rather than products alone:** mechanical resistance tests (peel, shear, …) of specific products are often used to evaluate the ageing impact on adhesive tapes (Fufa et al., 2018; Jucienė and Dobilaitė, 2021) but they seem to not be relevant to evaluate the airtightness durability of wall assemblies (Ylmén et al., 2014). Especially with implementation conditions for standardised mechanical resistance tests that could be too far from on-site conditions (Møller and Rasmussen, 2020).
- **All load types should be included in the protocol:** the impact of the various constraints (extreme temperature, humidity or pressure) is different depending on the air barrier type with plasters sensitive to humidity and temperature (cracks appeared when the plaster was too thin) and membranes sensitive to pressure variation (due to staples) (Michaux et al., 2014).
- **Necessity to test simultaneous loads:** this would be more representative of reality, and is necessary since for example the required temperature to induce significant wall airtightness deteriorations is lower when a pressure load is applied simultaneously (Litvak et al., 2019)

- **A general standardised procedure to test the airtightness durability of wall assemblies through artificial ageing is missing** (Ylmén et al., 2014)**:** the only existing standard on the durability of airtightness components in building is focusing on adhesive tapes with the ageing impact evaluated through peeling tests (DIN 4108-11) (Stefan Hückstädt, 2019)
- **The ageing strategy has to be consistent with real solicitation of products**: the strategy may differ for an exterior, indoor or embedded air barrier (Fufa et al., 2018).

2 LOADS ON THE AIR BARRIER AND EQUIVALENT ARTIFICIAL AGEING

Various load types are applied on the air barrier to test its durability through artificial ageing in laboratory, simulating more or less properly the natural ageing:

- Pressure load (mechanical ageing): rather easy to simulate.
- Thermal & humidity loads (physical ageing): difficult to estimate a correspondence between the artificial and natural ageing.
- Outdoor weathering loads (irradiation and wetting): different if the sealing product is intended for internal or external use.

3 RECOMMENDATIONS FOR FUTURE FIELD STUDIES

Recommendations were given in some studies to improve their test protocol and can be useful for anyone willing to perform further experimental studies in laboratory on this airtightness durability issue:

- **Wait at least 24 hours after the tightening of wall before the first tests:** this should avoid a release of tension in the joint during the ageing that could interfere with the durability evaluation (Møller and Rasmussen, 2020)
- **Use inert materials as sample holders:** to avoid wood expansion affecting the air permeability. If not possible, at least an initial measurement should be performed under saturated humidity conditions (Litvak et al., 2019)
- **Limit the duration of outdoor climate exposure tests for tapes intended for indoor application:** for durability tests simulating the potential maximum outdoor climate exposure during the construction period, the laboratory exposure time can be decreased from 2 weeks to 3 days for vapor barrier tapes (indoor application). In practice they should indeed not be exposed to solar radiation and moisture during the construction but still possibly during the transportation, storage or installation (Fufa et al., 2018)
- **Intensify the wind exposure test:** Increase the duration to at least 1000h, with higher pressure to represent more stressing conditions than urban areas (Litvak et al., 2019)
- **Perform more airtightness durability tests on various surfaces (like wood)** to confirm the significant airtightness deterioration (Møller and Rasmussen, 2020)
- For standardized mechanical resistance tests: **limit the number of substrates to one hard substrate** (as they all gave similar results) **and the intended flexible membrane** (vapor barrier or wind barrier) (Fufa et al., 2018)
- To perform not only mechanical tests but also **evaluate the chemical properties**, with the use for example of Fourier transform infrared spectroscopy (FTIR) or scanning electron microscope (SEM). (Fufa et al., 2018)

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