Assessment of the durability of airtightness products in laboratory controlled conditions:

development and presentation of the experimental protocol

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- The French research project **DURABILITAIR (2016-2019)**
  - ✓ *to improve our knowledge on the variation of buildings airtightness through onsite measurement campaigns (Task 2) and **accelerated ageing in laboratory controlled conditions (Task 3)***

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Lauréat de l'Appel à Projets de Recherche 2015 « vers des Bâtiments Responsables à l'Horizon 2020 »

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Introduction

- Literature review (task 1) pointed the importance of **well defining the sample to be tested** (products assembly v/s product alone) and the **ageing protocol conditions**.
- Due to the diversity of airtightness products, it is probably **impossible to define an accelerated ageing universal protocol** that would be equivalent to a known amount of years of natural ageing.

Introduction

- No standardized protocol / General conclusions can be drawn:
  - ✓ ***Implementation** has a strong impact on durability*
  - ✓ *Products do not have the same reaction **under normal** conditions as when they are subjected to **extreme conditions** (temperature, humidity or pressure);*
  - ✓ *A **standardized procedure** for the ageing of sealants is lacking to characterize products and especially **assemblies** regarding airtightness performance;*
  - ✓ *The results of ageing tests on **products alone** are not necessarily consistent with the ageing observed when these products are **put in situation**;*
  - ✓ ***Product performance** against conventional test procedures (peel, shear, etc.) does not necessarily correspond to their **performance in terms of airtightness***
  - ✓ *The ageing strategy must be consistent with the **loads** of the products. The strategy may differ depending on the **position of the air barrier**.*

Methodology

- We developed an experimental protocol for accelerated ageing of airtightness assembled products.
- The protocol definition consisted in :
  1) *developing an experimental chamber,*
  2) *choosing representative samples,*
  3) *defining the accelerated ageing conditions.*

Methodology

- Environmental chamber
  - ✓ *An accelerated weathering chamber (see A)*
  - ✓ *A pressure test bench for differential pressure exposure and airtightness measurement (see B)*
  - ✓ *A sample holder, between both enclosures (see C)*

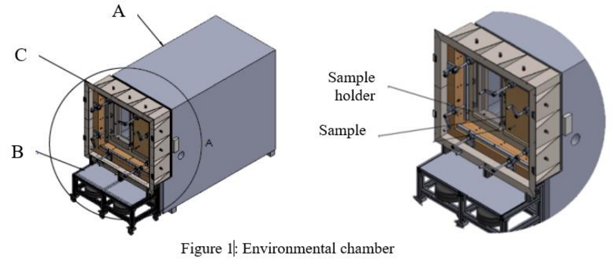
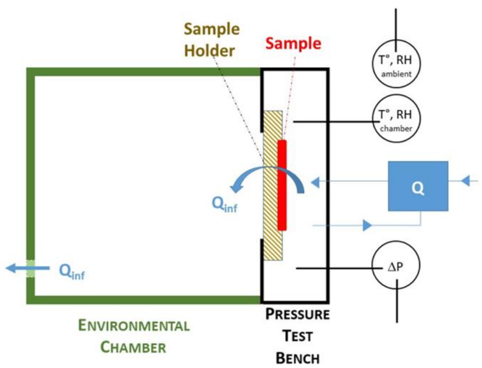


Figure 1: Environmental chamber

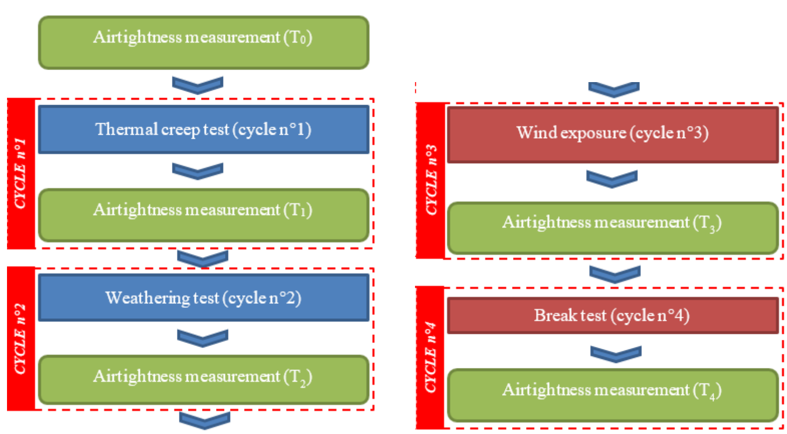
Methodology

- Environmental chamber



Methodology

- Exposure cycles and airtightness measurements



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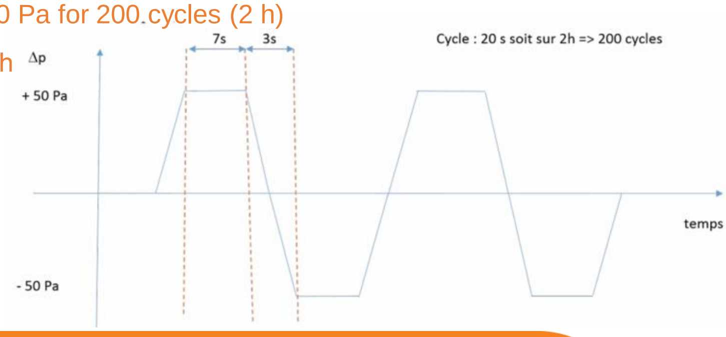
Methodology

- Exposure cycles and airtightness measurements

Cycle n°1 : « Thermal creep test »

- ✓ 60°C & 50%RH (for 21h)
- ✓ Wind cycle ±50 Pa for 200.cycles (2 h)
- ✓ Duration : ≈ 24h



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Methodology

- Exposure cycles and airtightness measurements

Cycle n°2 : « Four seasons »

- ✓ Summer : 30 °C & 45 % RH (24 h)
- ✓ Autumn : 5°C (24 h)
- ✓ Spring : 15°C & 60 % RH (24 h)
- ✓ Winter : -10°C (24 h)
- ✓ Stabilization period (12 h)
- ✓ Duration : (4,5 days)

Methodology

- Exposure cycles and airtightness measurements

Cycle n°3 : « wind test »

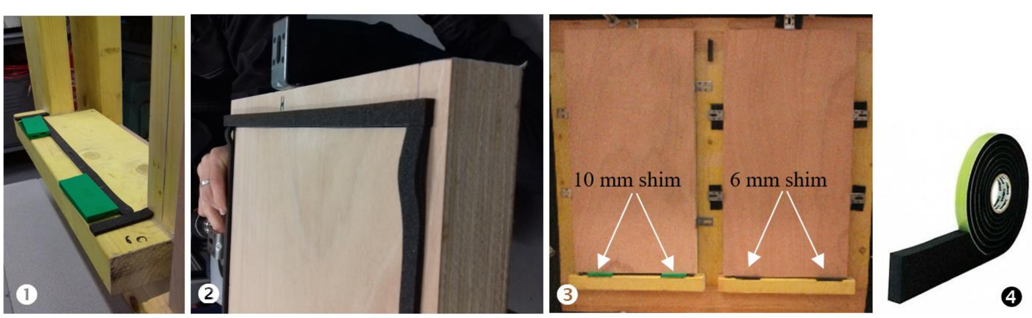
- ✓ Pressure cycles from -250 Pa to +250 Pa, (50 Pa steps)
- ✓ 8 hour cycles / 3 times
- ✓ total duration = 24 hours

Cycle n°4 : « Break test »

- ✓ Temperature increase : 1°C/min until T < 180 °C
- ✓ If no leakage, T = 180 °C for 1 hour

Methodology

- Samples :
  - ✓ Expansive weather seal foam ;
  - ✓ Sealant (mastic) with backing foam
  - ✓ Adhesive and membrane complex.



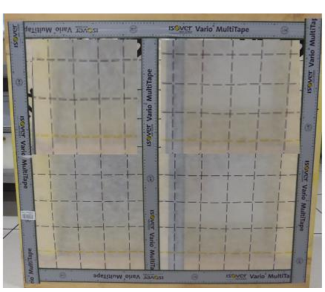
Methodology

- Samples :
  - ✓ Expansive weather seal foam ;
  - ✓ Sealant (mastic) with backing foam
  - ✓ Adhesive and membrane complex.

Successive steps for implementation of the assembled products. The opening of the carpentry was replaced by a plywood board.

Methodology

- Samples :
  - ✓ Expansive weather seal foam ;
  - ✓ Sealant (mastic) with backing foam
  - ✓ Adhesive and membrane complex.



– the cut-out membrane was positioned flat on the sample support at 3 cm from the edge of the left upright and centered in height
– the membrane was stapled on all edges by positioning a staple every 5 cm around orienting the staples at 45 °
– Adhesive tape was pasted on the central part taking care not to fold

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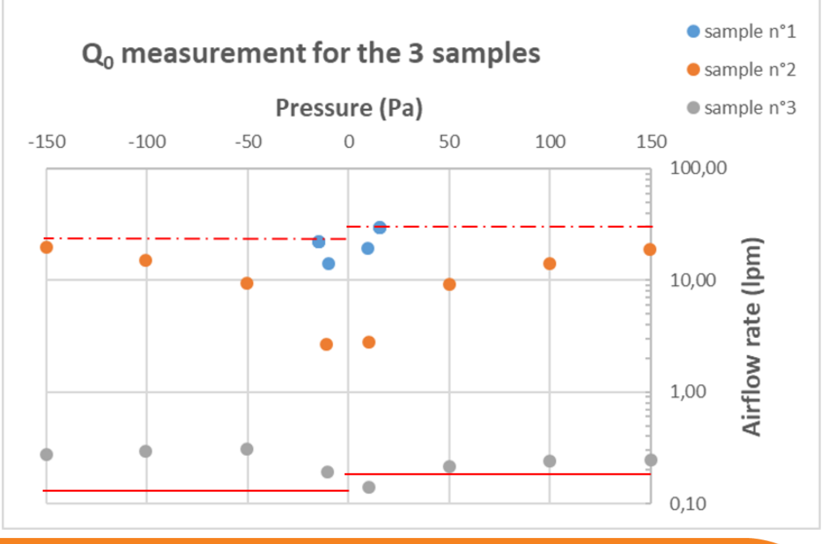
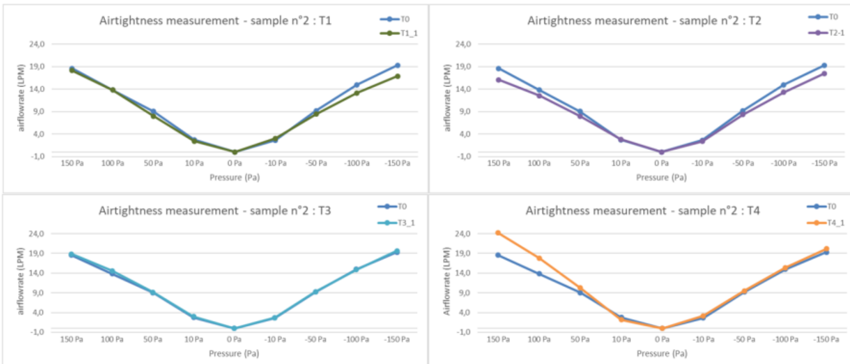
RESULTS

Initial measurements :

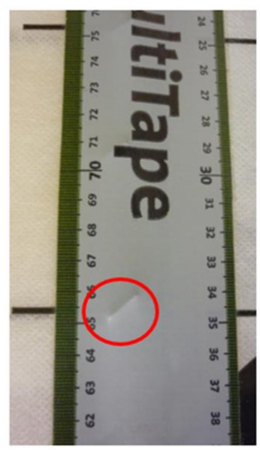


Evolution of air permeability flowrates for sample 2 for the weathering cycle (4 tests):



Evolution of air permeability flowrates for sample 3 for the weathering cycle (4 tests):

- Sample 3 was very airtight, thus, it was very sensitive to pressure variations (both positive and negative).
- We did not notice any significant deterioration of the air permeability flowrates for the first 3 tests of the cycle.
- For the break test (test n°4), the rupture occurred after 40 min, at the temperature of 60°C.



CONCLUSION

Conclusions

- The three types of samples made of assembled products as treatments of carpentry airtightness showed very different results, according to the maximum compensation capacity of the air permeability flow rate of the bench.
- Sample 1 (expansive weather seal foam) appeared to be too porous for our equipment, whereas Sample 3 (adhesive and membrane complex with staples) appeared to be too airtight.

Conclusions

- Sample 2 : The rupture occurred at 120 ° C and showed a significant decrease of the airtightness of the sample.
- We measured a slight deterioration of airtightness of up to +7%.
- Nevertheless, we could not draw any conclusion about the artificial ageing of the protocol, due to the elevated temperature of rupture. (the experimental conditions of test n°4 for sample 2 may probably contradict the statement "Never test products beyond their real life exposure conditions")

Conclusions

- The improvement airtightness during the ageing cycle of sample 2 is probably due to the humidity for the "thermal creep test" and the "weathering test" ; thus we recommend to use inert materials as sample holders for future works.
- Field measurement results from Task 2 about airtightness durability showed that wood structure houses tend to improve over years (Moujalled, 2019) ; probably due to the expansion of the wood with the humidity, that would clog leakages.

Conclusions

- **The wind exposure test 3 of the ageing cycle on sample 2 shows a very moderated increase of air permeability. We think that the duration of this cycle was too short, and that exposure durations of at least 1000 h (approximately, 1.5 month) should be necessary.**

- For future works, we plan to investigate a better **compromise** between **signal stability, usage range and control reactivit**y on airflow rate, and the exposure protocole conditions.

Thanks…

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