Field measurement of the durability of building airtightness- review and analysis of existing studies

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Tightvent Webinar 2020

Durabilit'air project

- 1st task of the Durabilit'air project

Founded by:

- Objectives of the project:
  - State of the art of major international research findings
  - Characterizing the evolution over time in mid and long term scales by on-site measurement campaigns
  - Developing a laboratory controlled method in order to test the accelerated ageing of airtightness systems;
  - Disseminating the main results of this work to promote best practices.

Objective of the state of the art

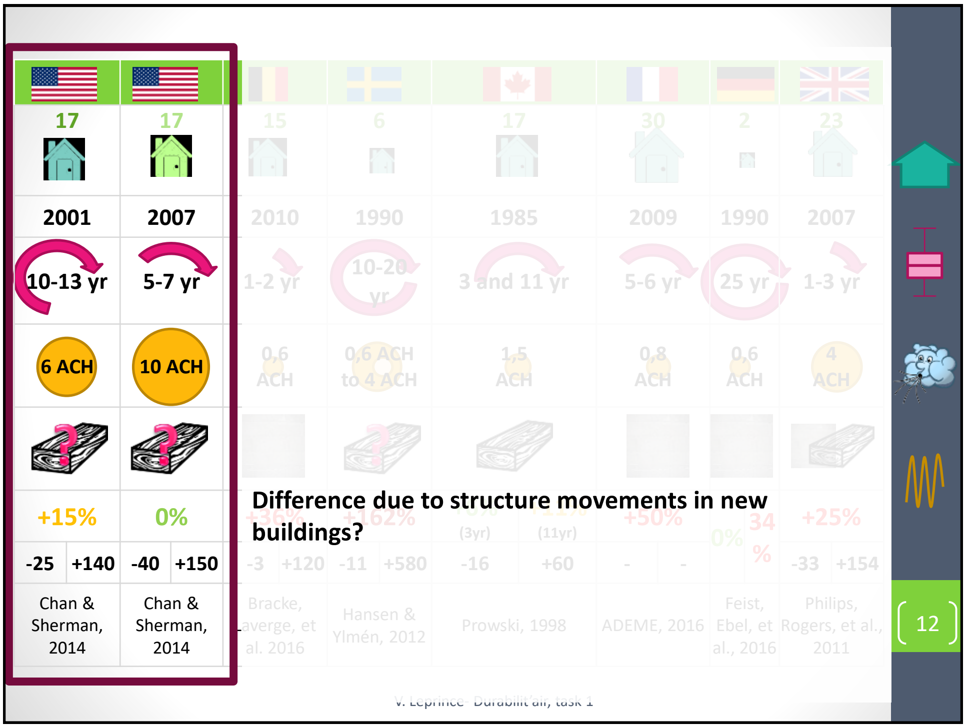
- Learn from previous studies
- Improve the protocol for the other tasks of the project
  - Field measurements
  - Laboratory testing

Durability tested on site

- In situ measurement
- Measurement uncertainty, seasonal variation

IN SITU MEASUREMENTS

17	17	15	6	17	30	2	23
2001	2007	2010	1990	1985	2009	1990	2007
10-13 yr	5-7 yr	1-2 yr	10-20 yr	3 and 11 yr	5-6 yr	25 yr	1-3 yr
6 ACH	10 ACH	0,6 ACH	0,6 ACH to 4 ACH	1,5 ACH	0,8 ACH	0,6 ACH	4 ACH
+15%	0%	+36%	+162%	+6% (3yr) / +11% (11yr)	+50%	0% / 34 %	+25%
-25 / +140	-40 / +150	-3 / +120	-11 / +580	-16 / +60	- / -		-33 / +154
Chan & Sherman, 2014	Chan & Sherman, 2014	Bracke, Laverge, et al. 2016	Hansen & Ylmén, 2012	Prowski, 1998	ADEME, 2016	Feist, Ebel, et al., 2016	Philips, Rogers, et al., 2011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10-13 yr
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6 ACH
10 ACH
0,6 ACH
0,6 ACH to 4 ACH
1,5 ACH
0,8 ACH
0,6 ACH
4 ACH
+15%
0%
Difference due to structure movements in new buildings?
(3yr)
(11yr)
+25%
-25 +140
-40 +150
-3 +120
-11 +580
-16
+60
-33 +154
Chan & Sherman, 2014
Chan & Sherman, 2014
Bracke, Laverge, et al. 2016
Hansen & Ylmén, 2012
Prowski, 1998
ADEME, 2016
Feist, Ebel, et al., 2016
Philips, Rogers, et al., 2011
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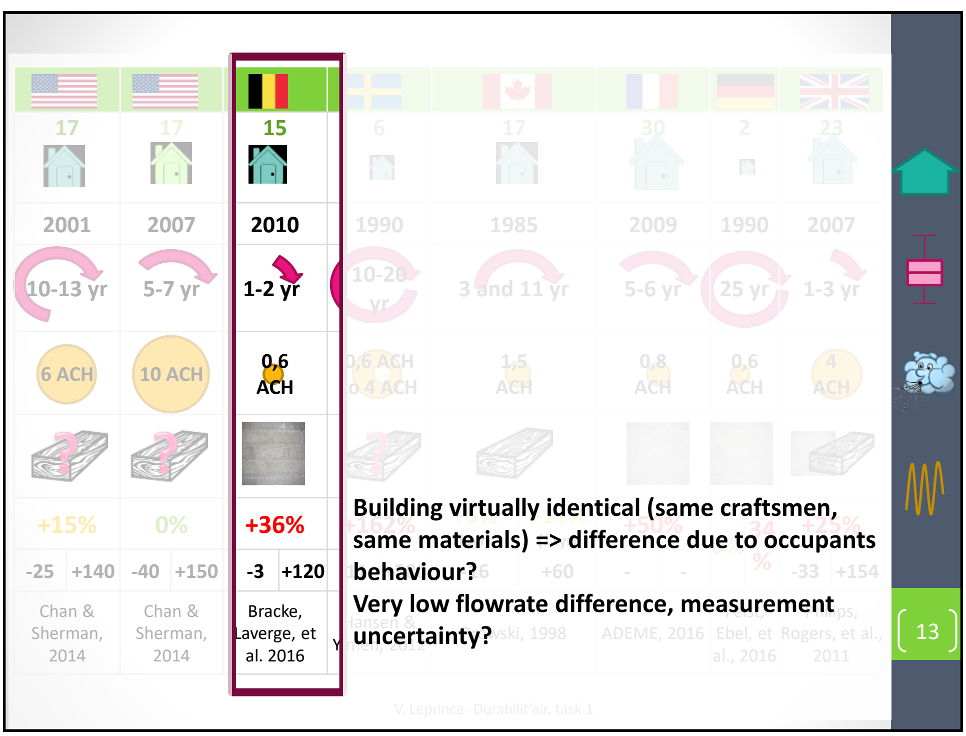
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+15%
0%
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Building virtually identical (same craftsmen, same materials) => difference due to occupants behaviour?
Very low flowrate difference, measurement uncertainty?
-25 +140
-40 +150
-3 +120
-33 +154
Chan & Sherman, 2014
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Half have increased, half have decreased, correlation neither with construction changes nor with age of the building

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Extended leakage detection: leaks appear at:

- **Penetrations of the air barrier;**
- **Electrical appliances;**
- **New non-airtight appliances (hood, recessed lighting, etc.).**

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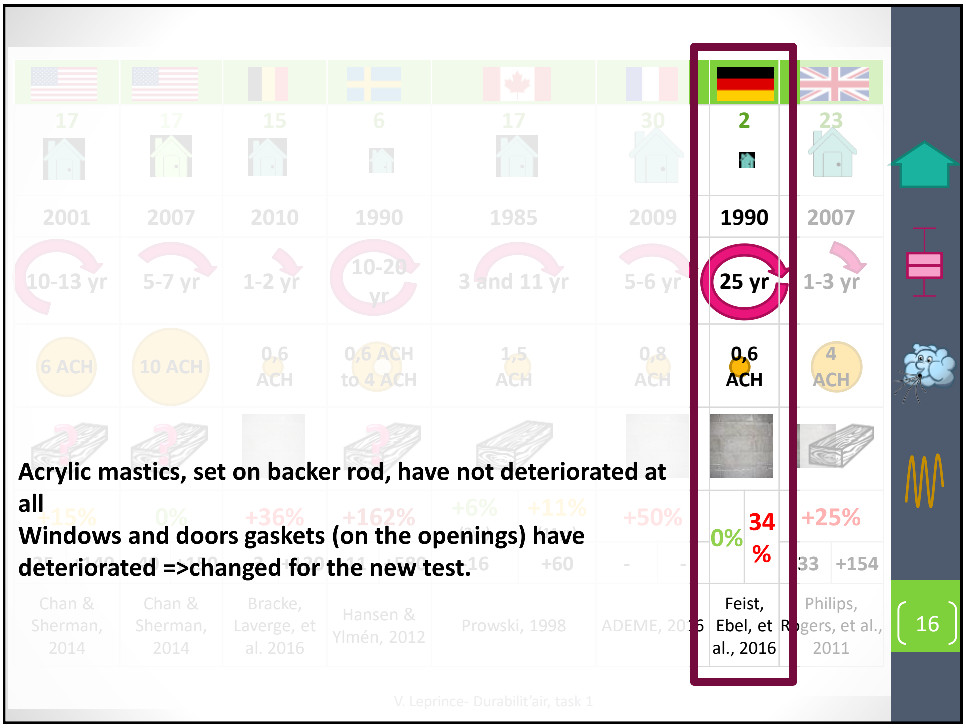
2
1990
25 yr
0,6 ACH
0%
34 %
Feist, Ebel, et al., 2016
Acrylic mastics, set on backer rod, have not deteriorated at all
Windows and doors gaskets (on the openings) have deteriorated =>changed for the new test.
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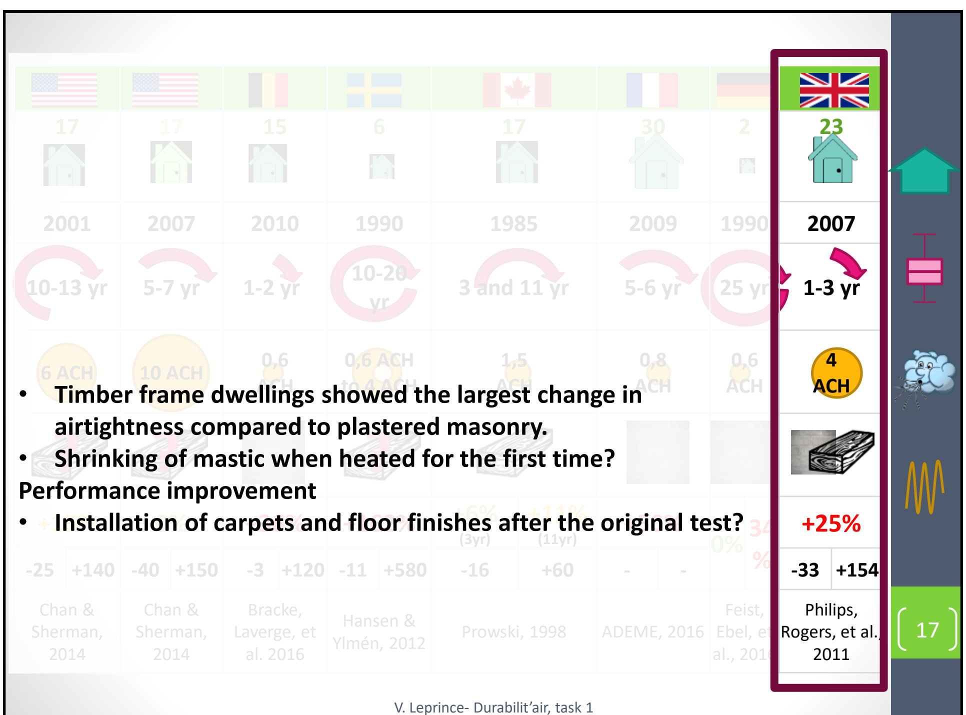
23
2007
1-3 yr
4 ACH
+25%
-33
+154
Philips, Rogers, et al. 2011
• Timber frame dwellings showed the largest change in airtightness compared to plastered masonry.
• Shrinking of mastic when heated for the first time?
Performance improvement
• Installation of carpets and floor finishes after the original test?
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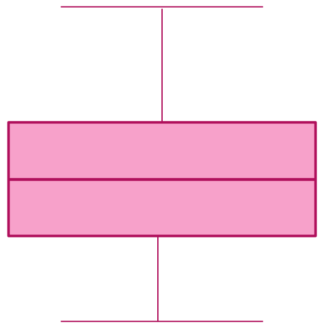
Conclusion on-site ageing

- Seems that the airtightness decreases in the first years after completion and then stabilises.
- Explanation factors:
  - Heating houses for the first time may induce the shrink of mastics
  - Mastic shrinking when backer rod are not used
  - Structure movements and packing may induce cracking in the junctions between air barrier and penetrations
  - Occupants behaviour: Envelope drilling (lot in the first years), etc.
  - Unsuitable implementation conditions for adhesives and mastic (cold and/or dusty conditions).

Impact on the testing protocol

- Questionnaires to occupants to find out drillings made in the air barrier.
- Leakage detection and visual inspection at visible assemblies of air barrier with specific care on:
  - mastics,
  - penetrations of building structure inside the air barrier (ex. carpentry).
- Information about:
  - Products used for the air barrier (use of backer road, compatibility of products)
  - Construction details
  - Period when the air-barrier was layed-out (heating period or not)?
  - Air-barrier heated prior to the first test?



MEASUREMENT UNCERTAINTY AND SEASONAL VARIATIONS

Measurement uncertainty: reference pressure of indicator

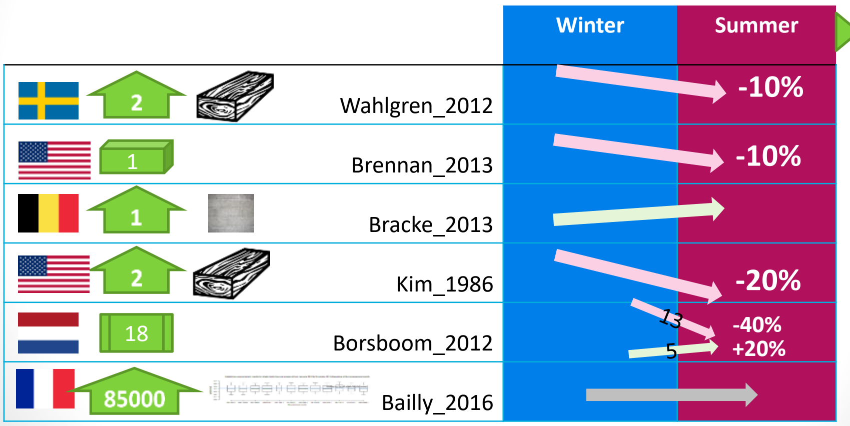
	4 Pa	50 Pa
Repeatability	3.5%	1.4%
Reproducibility	5.9%	2.4%
Wind impact(10m/s)	Max 60%	Max 12%

Sources: Delmotte_2011, Carrié_2014, Bracke_2014

Measurement uncertainty: seasonal variation

- Impact of **indoor humidity?**

$$\frac{Q_{50}}{\overline{Q_{50}}} = 0.991 \cdot \left(\frac{W_i}{\overline{W_i}}\right)^{0.11}$$



Impact on the testing protocol

- Reduce measurement uncertainty
  - Same qualified tester perform tests;
  - Reports precisely describe building preparation including locked and unlocked external doors.
  - Measurement devices calibrated according ISO 9972.
  - Measurements in low wind conditions.
  - Airtightness compared at 50Pa rather than 4 or 10 Pa.
    - In flowrate at 50 Pa rather than ratio (n50 or q50) take into account uncertainty
  - Average of pressurisation and depressurisation test
  - Better to perform test at the same season.

Conclusions

Airtightness changes through years

- Seems to decrease in the first years and then stabilise
- On site analysis required to explain measurement results

Low uncertainty required for interpretation

- 50 Pa indicator more reliable
- Test at same season if feasible

Thank you for your attention!

Questions?

Source: AIVC 2017 –Nottingham:
Publication available on Airbase

https://www.aivc.org/resource/durability-building-airtightness-review-and-analysis-existing-studies


Durability of building airtightness, review and analysis of existing studies