# BUILDING AND DUCTWORK AIRTIGHTNESS IN SPAIN: NATIONAL TRENDS AND REQUIREMENTS


Sergio Melgosa Revillas, eBuilding

Irene Poza Casado, Universidad de Valladolid




## VIP 45.2: Trends in building and ductwork airtightness in Spain

https://www.aivc.org/resource/vip-452-trends-building-and-ductwork-airtightness-spain

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Operating Agent
and Management
Boulevard Poincaré 79
B-1060 Brussels – Belgium
inive@bbri.be - www.inive.org

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Programme

Air Infiltration and Ventilation Centre

Trends in building and ductwork airtightness in Spain

Timo Hoek, airtest, Spain
Irene Poza-Casado, UVA, Spain
Sergio Melgosa, eBuilding, Spain

1 General Introduction

The Spanish residential stock is, on average, 45 years old and is in the lower part of the energy efficiency ranking, with an average valuation of 'E'. The market is recovering so vigorously from the Covid-19 hit that some voices in the sector warn that we are already facing the beginning of a new real estate "boom" that will continue until 2023. According to several projections, the number of dwellings in Spain could increase by 1,103,761 (5.9%) between 2020 and 2035, reaching 19,796,040.

As is the case at the European level, the non-residential market is the one with the most uncertain outlook: it has suffered a particularly negative year 2020 (-14.2%). The forecast for the following years includes growth (around 2.5% per annum) but it seems insufficient to recover the lost market volume. In a strict sense, it cannot be concluded that the global market is in a fragile situation, but niches with real momentum (logistics and offices) are coexisting with others where the demand raises questions. Although the Recovery Plan includes specific items for education, health and tourism, it is not expected that they will end up having a significant impact on construction [1].

2 Building airtightness

2.1 Introduction

Building airtightness has not traditionally been a major priority in the Spanish construction industry. Because most dwellings did not have any controlled ventilation systems, air infiltration has been a supplemental source of air renewal together with window airing, that contributed to indoor space air renewal [2]. From the point of view of research, knowledge on building airtightness is still scarce, owing to a lack of awareness about the subject. Whereas the topic has been widely addressed in the literature at an international level since the 1970s, little attention was paid on airtightness in Spain until a decade ago.

However, Spain is now on the change. Spanish building airtightness has only been present for windows and doors as an air permeability classification since 1975 [3], and, since 2006, according to UNE EN 12207 [4], when the Basic Document for the Energy Saving in Buildings (DB HE1) of the Spanish Technical Building Code (CTE) came into force [5]. The relative recent publication of the Royal Decree 732/2019, on 20th December 2019, modified the Technical Building Code. These modifications affected DB HE1 [6] and made the first statement limiting the whole air permeability of the building envelope.

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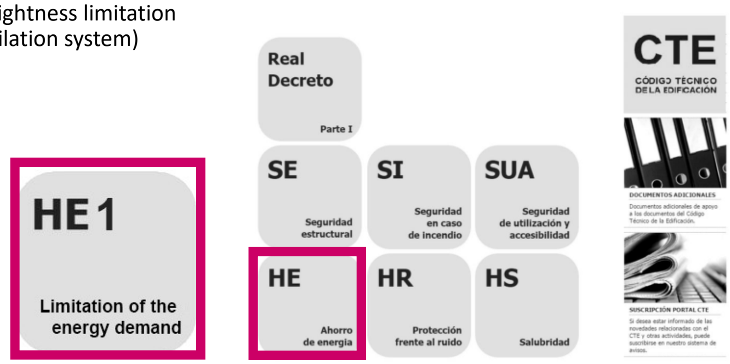
# BUILDING AIRTIGHTNESS



## Context

- No traditional awareness of airtightness
- Window permeability regulation since 1975 (RD 1490/1975)
- December 2019: whole building airtightness limitation (mandatory mechanical/hybrid ventilation system)



# Windows airtightness

Maximum airtightness values of windows per climate zone in winter ($m^3/h\cdot m^2$) at a pressure difference of 100 Pa

| Zone α | Zone A | Zone B | Zone C | Zone D | Zone E |
|---|---|---|---|---|---|
| **≤ 27** | **≤ 27** | **≤ 27** | **≤ 9** | **≤ 9** | **≤ 9** |

*where:* $q_{100}$ is the reference air permeability at a pressure difference of 100 Pa $[m^3/h\ m^2]$. *Note*: according to UNE-EN 12207, the permeability limit values correspond to Class 2 (≤ 27 $m^3/h\ m^2$) and Class 3 (≤ 9 $m^3/h\ m^2$). If a window has a rolling shutter, its permeability value should also include it. Climate zones A, B, C, D and E refer to Continental Spain. Zone α refers to the Canary Islands.



# Envelope airtightness

- New dwellings >120$m^2$
- Based on compacity (Volume/Area)

**Maximum $n_{50}$ [$h^{-1}$] values at a pressure difference of 50 Pa**

| Compacity V/A [$m^3/m^2$] | $n_{50}$ |
|---|---|
| V/A <= 2 | **6** |
| V/A >= 4 | **3** |

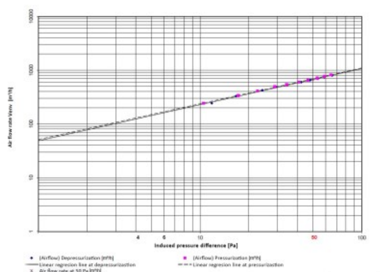
where: $n_{50}$ is the air change rate at 50 Pa $[h^{-1}]$; V is the internal volume of a building or part of a building $[m^3]$; $A_{ET}$ is the sum of areas of the thermal building envelope with heat exchange with the outdoor air. Therefore, internal partitions and the envelope area in contact with other adjacent spaces or buildings are excluded $[m^2]$. Note: the limit permeability values for intermediate V/A values can be obtained by interpolation.

# Building airtightness justification

**OPTION A**

**BlowerDoor test**

- ISO 9972, Method 2
- No other specification
- No qualification scheme for testers. The number of testers is unknown.




**OPTION B**

**Analytically**

$$n_{50} = 0.629 \cdot \frac{C_0 \cdot A_0 + C_h \cdot A_h}{V}$$

where:
$n_{50}$ is the calculated air change rate at 50 $Pa$ $[h^{-1}]$
$V$ is the internal volume $[m^3]$
$C_0$ is the airflow coefficient of the opaque part of the thermal envelope at a reference pressure of 100 $Pa$ $[m^3/h\,m^2]$. Reference values:

- New or existing buildings with improved airtightness, $C_0$ = 16 $m^3/h\,m^2$
- Existing buildings $C_0$ = 29 $m^3/h\,m^2$

$A_0$ is the sum of areas of the opaque thermal building envelope $[m^2]$
$C_h$ is the permeability of doors and windows in the thermal building envelope at a reference pressure of 100 $Pa$ $[m^3/h\,m^2]$
$A_h$ is the sum of the area of the doors and windows of the thermal building envelope $[m^2]$. The thermal building envelope consists of the building parts with heat exchange with the outdoor air. Therefore, internal partitions in contact with adjacent indoor spaces or buildings are excluded.



# Analytical model validation

- This is the widespread approach
- Input values of the energy performance calculation
- Airtightness test results were compared to calculated values
- Lack of linear association between the values of the CTE model and the test values

*I. Poza-Casado et al.* *Building and Environment 223 (2022) 109435*

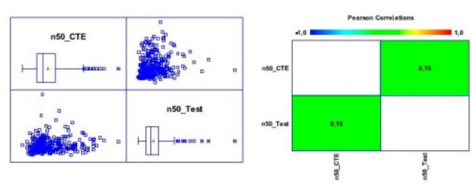



**Fig. 1.** Correlation analysis between the $n_{50}$ values obtained from pressurization tests and those computed using the CTE model.

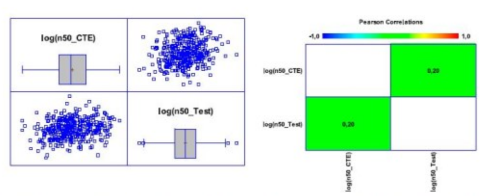



**Fig. 2.** Correlation analysis between the logarithms of the $n_{50}$ values obtained in the pressurization tests and those computed using the CTE model.

Poza-Casado, I., Rodríguez-del-Tío, P., Fernández-Temprano, M., Padilla-Marcos, M.-Á., & Meiss, A. (2022). An envelope airtightness predictive model for residential buildings in Spain. Building and Environment, 223(July), 109435. https://doi.org/10.1016/j.buildenv.2022.109435

# Building airtightness tests performed

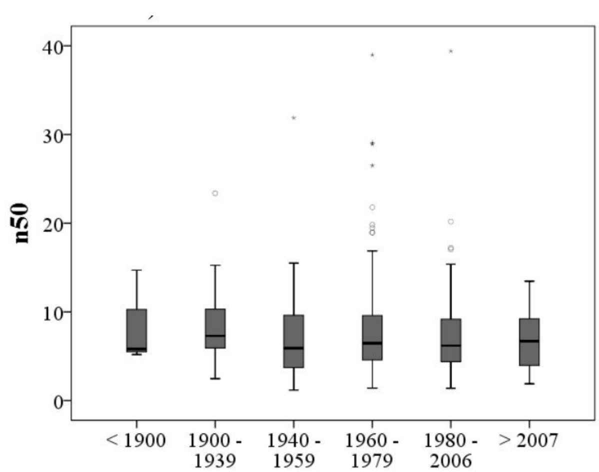
- No official data regarding testing
  - 2015-2019: increase in testing mainly promoted by voluntary certifications
  - 2019 onwards: slight increase
- No official airtightness database
  - Available data from research projects since 2011. INFILES Project, first representative sample of the Spanish residential building stock.
  - Unavailable data from companies


INFILES Project. Location of the cases.



# Evolution of the airtightness level

- Results from INFILES Project
- No statistically significant relation between airtightness and the period of construction
- Slight trend of improvement
- Reasons?
  - No concern
  - Traditional building systems
  - No requirements
- GAP: no recent data!!




Poza-Casado, I., Meiss, A., Padilla-Marcos, M. Á., & Feijó-Muñoz, J. (2018). Preliminary analysis results of Spanish residential air leakage database. 39th AIVC - 7th TightVent & 5th Venticool Conference "Smart Ventilation for Buildings." Retrieved from https://www.aivc.org/resources/collection-publications/aivc-conference-proceedings-presentations

# Conclusions

- Raised awareness for the past few years
- Positive progress towards energy-efficient buildings
- Trends towards:
  - More demanding limits
  - Mandatory compliance for buildings of any kind and size, at least for the most extreme climate zones
- Gaps:
  - Mandatory testing: real performance values
  - Airtighness database
  - Qualification frame for testers
  - Specific guidelines: testing and designing



# DUCT TESTING IN BUILDINGS

SERGIO MELGOSA REVILLAS

# REQUIREMENTS AND DRIVERS

- RITE, IT 1.2.4.2.3
- UNE-EN 12237, UNE-EN 1507 and UNE-EN 13403
- NO SPECIFIC QUALIFICATION



# What to test

- Single family houses 0%
- Multi-family houses 0%
- Public schools 0%
- Non public schools 10%
- Office Buildings 50%
- Hospitals 30%
- Other Buildings 10%

# EQUIPMENT FOR TESTING

Different equipment for different installation and preferences

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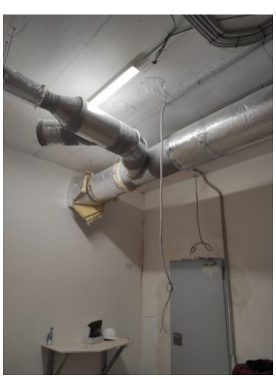
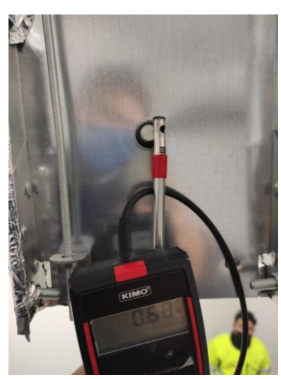
# LEAKAGES REPARTITION

- Derivations and unions (joints)
- Dumps and grills



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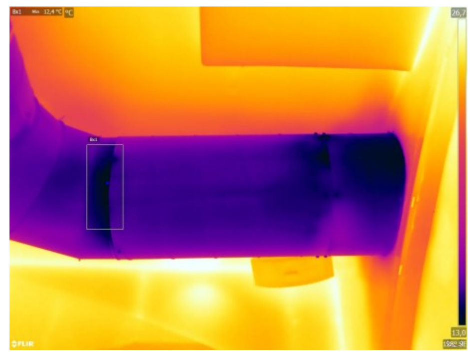
# FINDING THE LEAKAGES

- Anemometer, fog machine, Infrared termal imaging, noise, dirty joints





# Thank you!

smelgosa@ebuilding.es
irene.poza@uva.es