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Trends in building and ductwork airtightness in China

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01 Building airtightness

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— Introduction

- It was not investigated and discussed in China until 20 years ago
- Most studies focus on the northern regions (Severe Cold / Cold regions)

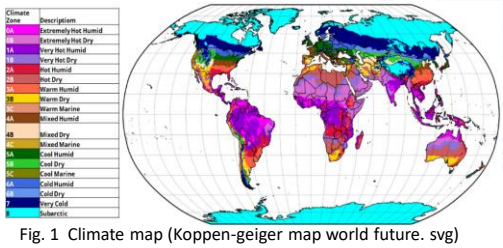

Fig. 1 Climate map (Koppen-geiger map world future. svg)

— Airtightness indicator

- N_{50}: h^{-1} Q_{50}: $m^3/(m^2 \cdot h)$

— Requirements and Drivers

- Building airtightness requirements in the regulation
  - GB/T 34010-2017: airtightness testing
  - GB/T 7106-2019: doors and windows
  - T/CECS 704-2020: whole building airtightness is graded

Table 1: The classification of the whole airtightness of buildings under natural pressure difference.

Level	1	2	3	4
Value/ h^{-1}	N>0.3	0.2<N ≤0.3	0.13<N ≤0.2	0.08<N ≤0.13
Level	5	6	7	8
Value/ h^{-1}	0.05<N ≤0.08	0.03<N ≤0.05	0.015<N ≤0.03	N≤0.015

01 Building airtightness

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- Building airtightness requirements in the regulation

Table 2: Airtightness requirements for ultra-low and nearly-zero energy buildings (GB/T 51350-2019)in different climate regions

Climate region	N_{50}/ h^{-1} Ultra-low energy buildings/ Nearly zero energy buildings	
	Residential buildings	Public buildings
Severe cold region	≤0.6	≤1.0
Cold region	≤0.6	≤1.0
Mild region	≤1.0	-
Hot summer and cold winter region	≤1.0	-
Hot summer and warm winter region	≤1.0	-

Fig. 2 Distribution of the five climatic regions for building design in China.

01 Building airtightness

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— Requirements and Drivers

- Incentive for building airtightness
  - Energy agencies in the capital cities of each province.
- Building airtightness justifications
  - T/CECS 704-2020, GB/T 34010-2017
  - Fan pressurization method, tracer gas method
- Sanctions
  - No mandatory requirement

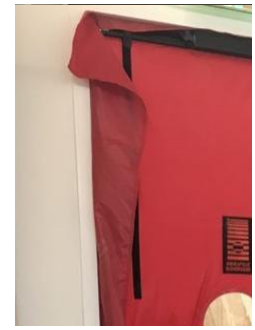

Fig. 3 DG1000 blast door air tightness test system

01 Building airtightness

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— Building airtightness in the energy performance calculation

- Calculation
  - DeST *(a energy performance calculation tool)*: inputting specific airtightness values of the whole building or windows.
  - Obtained by the tests based on the standards GB/T 7106, GB/T 34010, and T/CECS 704.
- Default values
  - T/CECS 704-2020

01 Building airtightness

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— Building airtightness test protocol

- Qualification of airtightness testers
  - No qualification scheme
- National guidelines
  - ~2020 : ISO 9972
  - 2020~ : T/CECS 704-2020
- Requirements on measuring devices

Table 3: Requirements for the accuracy of the measuring devices in Chinese standards.

Standard	Accuracy requirements		
	Pressure measuring devices	Temperature measuring devices	Airflow measuring devices
GB/T 34010-2017	±2 Pa	±1.0 K	Below ±7%
T/CECS 704-2020	±2 Pa	±0.2 K	-

— Building airtightness tests performed

- Northern region
  - ~2020 : Most of the buildings have serious air leakages
  - 2020~ : Moving towards a higher level of airtightness and energy efficiency

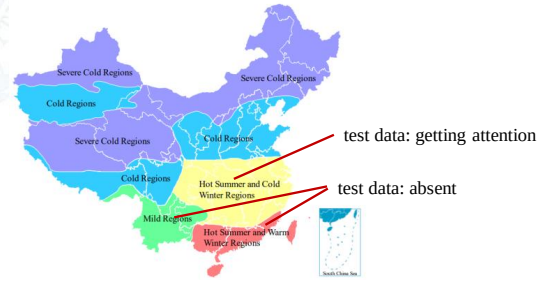

Fig. 4 Distribution of the five climatic regions for building design in China.

02 Ductwork airtightness

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— Introduction

- The air leakage ratio of ductwork of HVAC systems: around 18% in China
- Poor joints of ductwork is often as high as 10% to 15%

— Airtightness indicator

- Air leakage rate Q : m³/(m²·h)

$$Q = 3600 \cdot \varepsilon \cdot \alpha \cdot A_n \cdot \sqrt{\frac{2\Delta P}{\rho}}$$

  - expansion coefficient ε
  - flow coefficient α
  - opening area A_n
  - differential pressure ΔP
  - the air densityΔP

— Requirements and Drivers

- Ductwork airtightness requirements in the regulation (GB 50243-2016)

Table 4: Air leakage constant and air leakage limit per unit surface area for different types of ductworks (A is the rectangular metal duct; B is the round metal duct).

Ductwork type	P value	Air leakage constant		Permitted air leakage rate/ m³/(m²·h)	
		A	B	A	B
Low pressure ductwork	$P \le 500$	0.1056	0.053	$\le 0.1056P^{0.65}$	$\le 0.05 28P^{0.65}$
Medium pressure ductwork	$500 \le P \le 1500$	0.0352	0.018	$\le 0.0352P^{0.65}$	$\le 0.01 76P^{0.65}$
High pressure ductwork	$P \ge 1500$	0.0117	0.006	$\le 0.0117P^{0.65}$	$\le 0.01 17P^{0.65}$

02 Ductwork airtightness

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— Requirements and Drivers

- Incentive for ductwork airtightness
  - No information is available
- Ductwork airtightness justifications
  - Ductwork airtightness is tested usually when problems arise and the owners or managers permit it.
- Sanctions
  - No severely penalized

— Ductwork airtightness in the energy performance calculation (lack attention)

— Ductwork airtightness test

- Qualification of ductwork airtightness testers
  - No qualification scheme
- National guidelines
  - GB 50243-2016: ductwork inspection
  - GB 50591-2010: airtightness tests (only for the cleanroom air conditioning systems)
- Requirements on measuring devices
  - GB/T 2624-2006: for round duct
  - GB/Z 35140-2017: for rectangular duct

02 Ductwork airtightness

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— Ductwork airtightness tests performed

- Tested ductwork
  - Few large-scale tests
  - Constant pressure test method

$$Q_0 = Q(P_0/P)^{0.65}$$

  - air leakage rate at a specified pressure Q_0
  - measured air leakage rate Q
  - prescribed working pressure for ductwork tests P_0
  - tested pressure P

— Guidelines to build airtight ductwork

- GB 50738-2011, JGJ 141-2017 [35]
  - material selection, production, installation and inspection, etc., are stipulated.

03 Conclusions

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Building airtightness tests
— being promoted across the country

01

relevant standards & technologies
— gradually improved

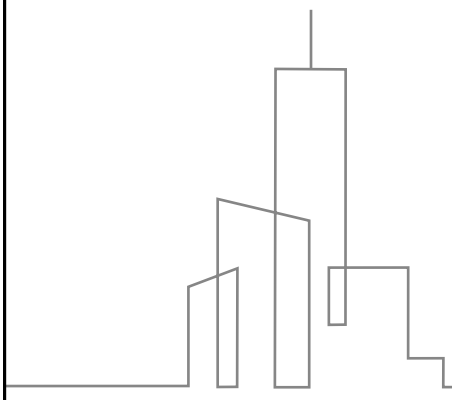
02

Ductwork airtightness
— has not received enough attention

03

relevant test standards
—need to be improved

04



Thank You !

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