



中國建築科學研究院
China Academy of Building Research

giz Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

建筑整体气密性在中国的应用 和面临的问题

Development and problems of air tightness of buildings in China

董宏 Dong Hong

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实践 Practice

实践 Practice

- 1988～1990年，中国建筑科学研究院
China Academy of Building Research (CABR)
 - 建筑物理研究所利用鼓风门法，对北京地区54套住宅进行了建筑气密性检测，提出了两种衡量建筑气密水平的标准推荐值，并建议将在建筑节能设计标准中提出气密性指标限值。
 - The Institute of Building Physics (IBP of CABR) used the blower door method to test the air tightness of 54 dwellings in Beijing. It proposed two sets of standard recommended values designed to measure the air tightness of buildings, and suggested that the limits of the air tightness index should be included in building energy efficiency design standards.

实践 Practice

- 2006～2011年，深圳市建筑科学研究院

Shenzhen Institute of Building Research (IBR)

- 通过对不同气候区域（沈阳和深圳）、不同类型（居住建筑和公共建筑）、不同建筑围护结构的气密性现场测试，研究室外环境条件（温度和风速）、建筑类型和围护结构形式对不同检测方法测试结果的影响，从而提出适合我国的建筑围护结构整体气密性现场检测方法和适用条件。
- The IBR tested the air tightness in different climatic zones (Shenyang and Shenzhen), different types (residential and public buildings), different building envelope structures to study the influence of outdoor environmental conditions (temperature and wind velocity), building types and envelope structures on the results of different testing methods, and put forward the onsite testing methods for the overall air tightness of building envelopes and applicable conditions which are suitable for China.

实践 Practice

- 2006年，中国建筑科学研究院 CABR
China Academy of Building Research (CABR)
 - 利用“鼓风机”建筑气密性检测设备对唐山、天津、乌鲁木齐、鹤壁四个城市的典型建筑进行了建筑整体气密性能测试。获取了大量既有建筑实测数据，了解了中国既有建筑整体气密性状况。
 - The CABR used the “blower door” building air tightness testing equipment to test the overall air tightness of typical buildings in Tangshan, Tianjin, Urumqi and Hebi, so as to obtain a large number of measured data on the existing buildings, and understand the overall air tightness of China’s existing buildings.

实践 Practice

- 2014年，大连理工大学

Dalian University of Technology

- 采用压差法对大连地区新建居住建筑的气密性进行了实测，并采用红外热像仪进行了空气渗漏点检测，同时对国内外建筑气密性评价指标进行了整理，将测试结果与德国建筑节能标准中的气密性限值及国外近期气密性测试结果进行了对比分析。
- The university used the pressure difference method to test the air tightness of the new residential buildings in Dalian, and used the infrared thermal imager to detect air leakage points. At the same time, it collected the evaluation index of air tightness of buildings at home and abroad, and made a comparative analysis on the test results and the air tightness limit value in Germany's building energy efficiency standards and the results of recent air tightness tests abroad.

实践 Practice

- 2015年，山东省建筑科学研究院
Shandong Academy of Building Research
 - 通过综述国内外关于建筑外围护结构气密性相关标准，比较了国内外标准的异同，并且针对我国建筑外围护结构气密性的现状及加强改进方面提出了相关建议。
 - The academy reviewed the standards of the air tightness of buildings' envelopes at home and abroad, compared the similarities and differences of those standards, and put forward suggestions on the current situation of the air tightness of Chinese buildings' envelopes and the aspects to be improved.

实践 Practice

- 2015年，中国建筑科学研究院 CABR
China Academy of Building Research (CABR)
 - 研究了建筑整体气密性对被动式建筑的重要性。提出既要提高建筑物门窗产品本身的气密性，又要保证门窗安装以及外墙、屋顶施工过程中的气密性，通过精细化施工实现被动式建筑的超低能耗。
 - The CABR studied the importance of overall air tightness to passive buildings. It proposed to both improve the air tightness of doors and windows of buildings, and guarantee the air tightness during installation of windows and doors and construction of exterior walls and roofs. It suggested that refined construction should be implemented to realize the ultra low energy consumption of passive buildings.

实践 Practice

- 2015年后，多家机构 Testing
 - 对建成的低能耗建筑、被动式建筑进行了现场测量。
 - Carried on field measurements on existing low energy consumption buildings and passive buildings.

序号	项目名称	所在地	竣工时间	建筑面积 (m ²)	气密性测试值 (n ₅₀ /h ⁻¹)
1	幸福堡商业综合楼	乌鲁木齐	2014.12	7791	0.2
2	吉林建筑大学城建学院超低能耗建筑	长春	2016.12	1187.8	0.6
3	辰能溪树庭院B4被动房	哈尔滨	2013.11	7775	0.6
4	奥润顺达被动式专家公寓	高碑店	2015.09	8016	0.3
5	“在水一方”被动式住宅	秦皇岛	2014.06	28050	0.26-0.54
6	淄博莲台养生养老院	淄博	2018.03	51100	0
7	潍坊“未来之家”	潍坊	2014.12	2287	0.20
8	金维度中德合作被动式国家示范项目	大连	2018	1024	0.18
9	烟台北航科技园	烟台	2017	3041.88	0.6
10	东莞圣融幼儿园	东莞	2012.06	3400	符合要求
				

实践 Practice

No.	Project Name	Place	Time of Completion	Floor Area (m ²)	Air Tightness Test Value (n ₅₀ /h ⁻¹)
1	Happy Village Commercial Complex building	Urumqi	2014.12	7,791	0.2
2	Ultra-low energy consumption building in the City College of Jilin Jianzhu University	Changchun	2016.12	1,187.8	0.6
3	CHENERGY Brook & Tree Courtyard B4 passive house	Harbin	2013.11	7,775	0.6
4	ORIENT SUNDAR passive expert apartment	Gaobeidian	2015.09	8,016	0.3
5	“Riverside” passive residential building	Qinhuangdao	2014.06	28,050	0.26-0.54
6	Zibo Liantai Health Nursing Home	Zibo	2018.03	51,100	0
7	Weifang “Future Home”	Weifang	2014.12	2,287	0.20
8	Gold Dimension Sino-German Cooperative Passive Building National Demonstration Project	Dalian	2018	1,024	0.18
9	Yantai Beihang Science and Technology Park	Yantai	2017	3,041.88	0.6
10	Dongguan Sheng Rong Kindergarten	Dongguan	2012.06	3,400	Meet the requirements
				

实践 Practice

- 2016~2017年，中国建筑科学研究院
China Academy of Building Research (CABR)
 - 受GIZ中德能源对话项目委托，对建筑整体气密性在中国的开展情况进行全面的调研。
 - Entrusted by GIZ's China-Germany Energy Dialogue Programme, the CABR conducted a comprehensive survey on the development of the overall air tightness of buildings in China.
 - 研究成果 Research results
 - 技术报告 Technical report
 - 政策建议报告 Policy recommendation report

实践 Practice

- 2016~2017年，中国建筑科学研究院
China Academy of Building Research (CABR)
 - 研究主要解决三个问题：The research focused on three topics:
 - 为什么要现阶段开展建筑整体气密性工作；
 - Why is it necessary to carry out work on the overall air tightness of buildings at the current stage?
 - 从技术角度如何确定并落实建筑整体气密性的要求；
 - How to determine and implement the requirements for the overall air tightness of buildings from a technical perspective?
 - 从政策角度如何支持并保证建筑整体气密性的实现。
 - How to support and ensure the realization of the overall air tightness of buildings from a policy perspective?

技术支持 Technical Support

- 2015年，建筑物的气密性（中文第一卷）
- 2015, Air tightness in building (volume 1), GIZ
 - 该书“涵盖有关建筑气密性方方面面的问题”，如：
 - 为什么要重视建筑的气密性； Why should we pay attention to the air tightness of buildings?
 - 气密性的历史； The history of air tightness;
 - 气密性测试技术； **The technology of testing air tightness;**
 - 实现气密性所需的材料和施工要求； The materials needed to achieve air tightness and construction requirements;
 - 气密性建筑的通风技术； The ventilation technology for buildings with air tightness;
 - 德国关于气密性的法律法规等。 German laws and regulations on air tightness.

技术支持 Technical Support

- 2015年，建筑物的气密性（中文第一卷）
- 2015, Air tightness in building (volume 1), GIZ
 - 该书为中国在建筑气密性应用研究方面提供了急需技术支持，特别是在气密性测试理论和方法。
 - The book provides much-needed technical support for China's applied research on the air tightness of buildings, especially in the theory and method of air tightness testing.



buch / band 1

Fachverband Luftdichtheit im Bauwesen e.V.

Band 1



■ Gebäude-Luftdichtheit

Band 1

Gründe für eine Luftdichtheit der Gebäudehülle
Anforderungen im Wandel – Luftdichtheit damals und heute
Messung der Luftdurchlässigkeit der Gebäudehülle
Kleben - Materialien und Verarbeitung
Lüftung in luftdichten (Wohn-)Gebäuden
Die Luftdichtheit der Gebäudehülle im öffentlichen und privaten Baurecht

Zweite, aktualisierte Auflage



德国建筑气密性专业协会 第一卷

第一卷



■ 建筑物气密性

第一卷

建筑外围护结构气密性的原因
要求的沿革 – 气密性的过去和现在
建筑外围护结构透气性测量
粘贴 – 材料和准备
气密性 (居住) 建筑的通风
公建法和自建建筑法中的建筑外围护结构气密性

第二次修订版
资助、负责中文版翻译及在中国推广。



技术支持 Technical Support

- 2017年，建筑物的气密性（中文第二卷，部分）

Air tightness in building (volume 2 , parts), GIZ

- “第二卷不仅会延续第一卷的内容，而且会扩大专题范围，充实理论分析特别是实践方面的问题”，主要内容包括：“The second volume will not only extend the content of the first volume, but also expand the scope of the topic, and enrich the theoretical analysis, especially practical aspects.” The main contents include:

- 气密性方案导则； **Guidelines on air tightness;**
- 气密层粘贴的基本知识； Basic knowledge of air tightness layer pasting;
- 既有建筑中气密性的实施； The implementation of air tightness in existing buildings;
- 通过裂隙和开口的换气； **Ventilation through fissures and openings;**
- 测试实践； **Test practice;**
- 气密性的使用寿命和工程合同问题。 The service life of air tightness and engineering contract.

技术支持 Technical Support

- 2017年，建筑物的气密性（中文第二卷，部分）
Air tightness in building (volume 2 , parts), GIZ
 - 第二卷在换气理论方面进一步深入，并且丰富了测试实践的内容。GIZ将中国深入开展气密性研究和应用急需的部分翻译成中文，将能够很好地满足中国需求。
 - The second volume deeply analyzes the theory of ventilation and enriches the content of test practice. GIZ might translate the parts much needed in China for the in-depth research and application of air tightness, which will meet the country's needs in this regard.

标准 Standard

检测标准 Testing Standards

- 《民用建筑节能现场检验标准》 *Energy conservation on-site testing standard for heating civil buildings, DB11/T 555-2008*
 - 北京地区地方标准，该标准给出了建筑整体气密性的检测方法（压差法、示踪气体法），适用于北京地区民用建筑工程节能效果现场检验，既有建筑节能效果检验可参照执行。
 - Local standards in Beijing. This standard gives the test method of the overall air tightness of buildings (pressure difference method, tracer gas method), which is applicable to the field test of energy saving effect of civil building projects in Beijing. This Standard can be referred to for the inspection of energy-saving effects of existing buildings.
- 《公共建筑节能检测标准》 *Standard for energy efficiency test of public buildings, JGJ/T 177-2009*
 - 建筑工程行业标准，该标准在附录中规定了建筑外围护结构整体气密性的检测方法（压差法）。
 - Standard of the construction engineering industry. In the appendix, this Standard stipulates the method (pressure difference method) to measure the overall air tightness of building envelopes.

检测标准 Testing Standards

- 《建筑物气密性测定方法 风扇压力法》 *Standard for determination of air permeability of buildings—Fan pressurization method*, GB/T 34010-2017
 - 国家标准，该标准等同采用ISO 9972:2006 (2009 ADM 1)
 - National standard, which is equivalent to ISO 9972:2006 (2009 ADM 1)
 - 2018年06月01日实施
 - Will come into force on June 1, 2018
- 《建筑整体气密性检测及性能评价标准》 *Standard for the determination of air tightness and performance evaluation of buildings*
 - 工程建设标准化协会标准（CECS），2017年10月立项
 - 主编单位：中国建筑科学研究院
 - 2017年10月~2019年10月制订完成
 - 主要内容包括：总则、术语、建筑整体气密性检测要求和分级等
 - Standard of China Association for Engineering Construction Standardization (CECS); initiated in October 2017
 - Compiled by China Academy of Building Research
 - Period of preparation: October 2017 ~ October 2019
 - The main contents include: general provisions, terminology, the requirements for and grading of the overall air tightness of buildings.

产品标准 Product Standards

- 《建筑外窗空气渗透性能分级及其检测方法》 *Graduation of air permeability and their test method for windows, GB/T 7107-87*

	5	4	3	2	1
m ³ /(m h)	5.0≥q1 > 4.0	4.0≥q1 > 2.5	2.5≥q1 > 1.5	1.5≥q1 > 0.5	q1≤0.5

- 《建筑外窗气密性能分级及检测方法》 *Graduation and test method for air performance of windows, GB/T 7107-2002*

	1	2	3	4	5
m ³ /(m h)	5.0≥q1 > 4.0	4.0≥q1 > 2.5	2.5≥q1 > 1.5	1.5≥q1 > 0.5	q1≤0.5

- 《建筑外门窗气密、水密、抗风压性能分级及检测方法》 *Graduations and test methods of air permeability, watertightness, wind load resistance performance for building external windows and doors, GB/T 7106-2008*

	1	2	3	4	5	6	7	8
m ³ /(m h)	4.0≥q1 > 3.5	3.5≥q1 > 3.0	3.0≥q1 > 2.5	2.5≥q1 > 2.0	2.0≥q1 > 1.5	1.5≥q1 > 1.0	1.0≥q1 > 0.5	q1≤0.5

设计标准 Design Standards

- 《民用建筑节能设计标准（采暖居住建筑部分）》（JGJ26-86） *Energy conservation design standard for new heating residential buildings*
- 《民用建筑节能设计标准（采暖居住建筑部分）》 JGJ 26-95 *Energy conservation design standard for new heating residential buildings (JGJ 26-95)*
- 《严寒和寒冷地区居住建筑节能设计标准》 *Design standard for energy efficiency of residential buildings in severe cold and cold zones, (JGJ26-2010)*
- 《严寒和寒冷地区居住建筑节能设计标准》 *Design standard for energy efficiency of residential buildings in severe cold and cold zones, (JGJ26-201X)*
 - 工程建设行业标准，2015年11月启动修订
 - 主编单位：中国建筑科学研究院
 - 2015年11月~2018年06月修订完成
 - Standard of the construction engineering industry. Revision was started in November 2015
 - Compiled by China Academy of Building Research
 - Period of revision: November 2015 ~ June 2018

设计标准 Design Standards

- 《夏热冬冷地区居住建筑节能设计标准》 *Design standard for energy efficiency of residential buildings in hot summer and cold winter zone*, (JGJ 134-2001/2010)
- 《夏热冬暖地区居住建筑节能设计标准》 *Design standard for energy efficiency of residential buildings in hot summer and warm winter zone*, (JGJ 75-2003/2012)
- 《公共建筑节能设计标准》 *Design standard for energy efficiency of public buildings*, (GB 50189-2005/2015)
- 《温和地区居住建筑节能设计标准》 *Design standard for energy efficiency of residential buildings in temperate zone*
 - 工程建设行业标准，2014年启动制订
 - 2017年10月30日，通过审查，准备报批
 - Standard of the construction engineering industry. Revision was started in 2014.
 - On October 30, 2017, the Standard passed review to be ready for approval

重要性 Importance

重要性 Importance

- 对建筑能耗的影响 **Impact on building energy consumption**
 - 提高建筑的整体气密性是进一步提升建筑节能目标的重要途径
 - To improve the overall air tightness of buildings is an important way to further improve energy efficiency in buildings

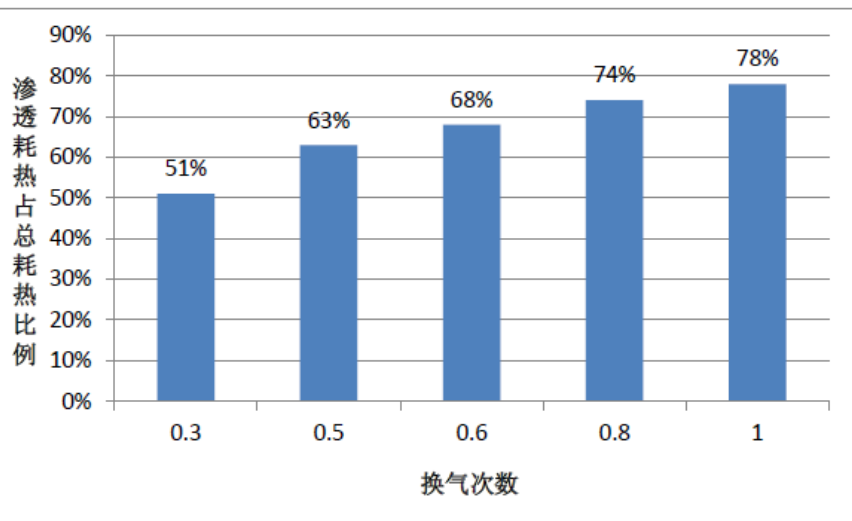


表 3.3 不同节能设计标准参考建筑耗热量对比

	通过单位面积围护结构传热量(W/m ²)	建筑物空气渗透耗热量(W/m ²)	建筑物总耗热量指标(W/m ²)	空气渗透耗热量占总耗热量比例 (%)
65%节能设计标准	7.123	5.796	9.119	63
75%节能设计标准	5.413	5.796	7.409	78

图 3.3 不同气密性水平渗透耗热占建筑总耗热量比重变化

重要性 Importance

- 对室内空气品质的影响 **Impact on indoor air quality**
 - 雾霾频发
 - Frequent smog



图片来自于网络

重要性 Importance

- 建筑工业化的影响 **Impact of construction industrialization**
 - 预制构件现场拼装
 - The onsite assembly of prefabricated components



Photos from the
Internet

问题 Problems

问题 Problems

- 认知 **Cognition**

- 中国人习惯了开窗通风，讲究“穿堂风”、“对流风”，尤其是我国南方地区，开窗成为了最常见的通风换气方式。没有认识到建筑整体气密性对建筑室内及建筑能耗的影响。
- Chinese are accustomed to opening windows for ventilation and are particular about “draft” and “convection wind”. Especially in southern China, opening windows has become the most common mode of ventilation. Chinese have not realized the impact of overall airtightness of buildings on the indoor environment and energy consumption.

- 设计 **Design**

- 与节能、室内空气品质间的平衡
- 建筑整体气密性与门窗气密性的关系
- 对节能的定量评价
- 装配式建筑中的整体气密性
- The balance with energy efficiency and indoor air quality
- The relationship between the air tightness of buildings and that of windows and doors
- The quantitative evaluation on energy conservation
- The overall air tightness of prefabricated buildings

问题 Problems

• 施工 Construction

- 非采暖空间与采暖空间的气密性处理
- 门窗洞口的密封构造
- 装配式建筑的节点构造、材料、施工方法
- The air tightness treatment of non-heating space and heating space
- The sealing structure of door and window openings
- The joint construction, materials and construction method of prefabricated buildings

• 验收 Acceptance

- 建筑整体气密性的检测
- 建筑整体气密性的评价
- Testing of the overall air tightness of buildings
- Evaluation on the overall air tightness of buildings

• 能力 Ability

- 从业人员的能力是设计、建造、检测的核心，是建筑整体气密性实现的保证。
- The ability of practitioners is the core of design, construction and testing, and also an important factor to ensure the overall air tightness of buildings.



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谢谢
THANKS

