SCIREA Journal of Sociology

http://www.scirea.org/journal/Sociology

January 12, 2023

Volume 7, Issue 1, February 2023

https://doi.org/10.54647/sociology84959

Relevance of natural light design in glass curtain wall of high-rise office building

Kim Chul-soo[1], Zhang wu[1]

[1] Pukyong National University, 45Yongso-ro, Nam-gu,Busan，Korea

Abstract

For a long time, natural light has been accompanied by human growth and has been applied to buildings in various forms. With the development of urbanization, the development of high-rise and large-scale buildings has become an inevitable trend. The significance of biological light for "non-visual effects" is only beginning to be researched internationally as a way to establish the link between light and health. The role of natural light can not be substituted for ordinary light sources, pure light is rich in a large number of short-wave light, is currently artificial lighting can not be simulated. Research on mental illness in the United States in the 1980s found that a psychiatric disease. Seasonal Affective Disorder (SAD), is strongly related to the amount of natural light a person receives. SAD, also known as "winter blues", is not abnormal most of the time, but can show symptoms of significant depression in the cold, light-deprived winter months.

Keywords: Natural light，Green buildings, Glass curtain wall , Energy Saving , High-rise

office building

1. Survey of the current situation

The main problems of current office space natural lighting design are.

1)Poor illumination uniformity: large depth, illumination decreases sharply along the depth, so that the illumination value is higher at the window position and low indoor illumination value.

(2) glare problem: window position illuminance value is high. Easy to produce glare. As the office space, the side window is the main channel for natural light to enter the room, in today's dense office space, most people choose the window position in order to get sunlight and fresh air. However, the area of the side window light opening is often quite inadequate to meet the illumination requirements inside the office space.

In the architectural design process, the following ways are usually used to improve these problems.

I.Using skylights, light wells and atriums to increase the internal lighting of the building.

Ii. The use of auxiliary lighting systems to shade some of the direct light while directing some of the light into the space, thus increasing the illumination level of the interior space and reducing the risk of glare from the window positions.

The design of office space is mainly dependent on the characteristics of the site itself, from the functional requirements, judicious arrangement of traffic flow, comprehensive consideration of technical, aesthetic and other factors, so as to constitute the result of the architectural space. Its architectural form varies and the space form varies. The commonplace forms of space combination are outer corridor type, inner corridor type, inner courtyard type and atrium type. As shown in Figure 1.

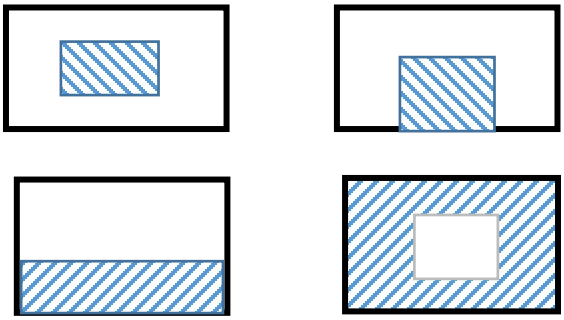


Figure 1 Natural lighting space combination form

Architects choose different forms of laminated glass curtain wall, not only to make the building more transparent, but also can be more design sense.

Glass curtain wall is a little bit as following 3 points.

I. Resist temperature changes. When the external temperature changes, the structure will be thermal expansion and contraction. If no measures are perceived, the structure will be squeezed and bent in the summer, crushed; winter will pull the structure cracked and broken. Therefore, long pavements should be split into joints, and tall buildings should also serve as divided into sections with temperature joints, thereby reducing the impact caused by temperature changes. High-rise buildings cannot use horizontal segmentation to solve the problem of temperature change, but can only use the building curtain wall to envelop the whole structure, so that the structure is in the interior and the temperature no longer changes, thus reducing the damage to the structure and ensuring the safety of the main structure. This is a part of the main reasons why building curtain walls must be used in high-rise buildings.

II. Resist earthquake disaster. 1995 Japan Hanshin earthquake, Taiwan in 1999, China's set of large earthquake, the epicenter of the intensity of 11 or more, masonry filler walls were destroyed in large numbers, while the glass curtain wall is rarely bad earthquake reports, most of the preservation after the earthquake intact. This results from the fact that the curtain wall is usually composed of panels (glass, aluminum, stone, ceramic panels, etc.) and the supporting structure behind. Since there are wide joints between the panels and the connection points between the panels and the crossbeam columns have mobility. Curtain walls can withstand relatively large deformation in the plane.

III. Curtain wall saves the construction cost of structure and foundation. Building materials,

such as steel and cement are high energy-consuming and costly materials. To save materials is to save energy and resources. In the cold winter, residents living in transparent glass curtain wall building, can enjoy the warmth of the sun more; in the hot summer, high-rise buildings can be double reflective glass curtain wall, thus better able to keep the interior cool, saving energy used for heating and cooling.

Figure 2 Material composition

The energy consumption of office space mainly lies in: air conditioning, heating, lighting, transportation, office equipment, hot water and other aspects. Data from European office projects show that the important determinants of energy consumption characteristics of office space lie in the characteristics of the building itself, such as body coefficient, degree of site openness, building skin and its construction, internal equipment operation efficiency, shading measures and other factors are closely related.

Be compared to other public buildings, office space has relatively special energy consumption characteristics.

1) high energy consumption for lighting.

2) relatively dense personnel, many lighting and office equipment, and more heat sources in the space.

3) More use and high energy consumption during the day, less use and low energy consumption at night.

2. Office space and natural light

2.1 History and development of natural light

Natural light has been used since the early days of human civilization, when people began to

use holes in roofs or walls to obtain pure light, with the 9-meter diameter circular light opening at the top of the ancient Roman Pantheon being the most famous. With the outbreak of the energy crisis, there were changes and innovations in building systems, materials and design, especially in the late 1990s, when increasing attention was paid to improving energy efficiency and natural light was widely used as a highly efficient source of energy, resulting in a strong development of natural lighting science and technology, with world-renowned architects such as Foster and Herzog applying new lighting technologies to their works.

2.2 The influence of natural light and office space

Seasonal AffectiveDisorder (SAD) can show symptoms of depression in the winter when there is not sufficient light, and this symptom can be improved by extending the right time and going out to receive more sunlight. Most high-rise buildings use glass curtain walls, which enhance the neutral rate inside the building.

Introducing natural light into the office space can make people feel the change of time and the change of seasons, soften the cold and hard office box, enrich the office space, and also satisfy the human subconscious desire for nature, promote the physical and mental health of office workers, relieve work stress and regulate mood. The hypothesis of the physiological principle of melatonin proposed by the Lighting Research Center also explains to some extent the principle of natural lighting to improve work efficiency. [Rea MS, Bullough JD, Figueiro MG. Circadian photobiology: a new framework for lighting practice, Lighting research and technology, in press [34] Rea MS, Bullough JD, Figueiro MG. Human melatonin suppression by light: a case for scotopic efficiency. Neuroscience Letters 2001,299:45-8] Many studies on office space productivity have shown that if employees are distributed to a safe, healthy and comfortable office space environment, employee productivity will be increased and companies can reap higher benefits.

2.3 people and natural lighting

Office is an important place for people's everyday work. The quality of office space in the light environment is not only related to people's eye health, but also has an impact on their psychological feelings and physiological changes and other biological responses.

The existing lighting design specifications only regulate the visual effects such as illuminance and illuminance uniformity, and the lighting performance is only evaluated based on the lighting coefficient, room depth and glare index, without considering the role of light biological effects; at the same time, there is also a lack of visual efficacy research for different regional light climate, seasonal periods, and lighting port orientation, thus failing to accurately reflect the actual lighting effects of office premises and workers' physiological and psychological feeling. Therefore, under the guidance of pharmacological effect theory, research more suitable for office space lighting design concepts and measures, not only the physical and mental health of office workers, but also has the significance of meeting the building lighting energy saving, so as to achieve the purpose of green lighting and health lighting.

A good light environment will have a positive impact on human mental state and tun, reasonable feeling. For production, work and study places, a good and comfortable light environment can uplift the spirit, improve efficiency and product quality.

2.4 Improvement directions:.

1) Materials can be used to change the light into the interior of the building to make the interior of the building more comfortable.

2) Eliminate the curtains directly.

3. Let the internal consumption of the building can also be reduced

Use biofilm for the whole building

-- change the light source inside the building.

Adjust the microclimate inside the building

3.1 color-changing glass for high-rise office building glass facade

In the United States, there are high-rise buildings, the higher it is built, the heavier it is itself. Now the architects proposed to use frame structure to build the building, so that the whole

building is supported by a metal frame, the building's exterior walls no longer play a load-bearing role, so you can use a light texture, good light transmission, and more beautiful glass curtain wall. In addition to building functional and architectural art factors, there are other important reasons for using a glass curtain wall, such as safety and protection, energy saving and cost saving factors.

3.2 Energy Saving

office space in the whole life cycle of energy consumption is huge, not only in the development and construction phase to consume a lot of material energy, in the latter operation process, also consume huge energy. Under the influence of the "curtain wall fever", many glass curtain wall high-rise office buildings have risen and distribute over the entire Chinese land, further aggravating the energy consumption problem of office space. The energy consumption of office space mainly lies in: air conditioning, heating, lighting, transportation, office equipment, hot water and so on. Data from European office projects show that the important determinants of the energy consumption characteristics of office space lie in the characteristics of the building itself, such as the volume factor, the degree of openness of the site, the skin of the building and its structure, the operational efficiency of internal equipment, shading measures and other factors are closely related.

3.3 Principle of Transformation

Photochromic glass is an eyeglass made of color-changing glass. The appropriate wavelength of light irradiation to change its color, and the removal of the light source will return to its original color of the glass. Also called photochromic glass or photochromic glass. Photochromic lenses become darker in sunlight when subjected to ultraviolet light and short-wave visible light, and the light transmission rate decreases; indoors or in the dark, the subtle transmission rate increases and the color fades back to light. Photochromic properties of lenses are automatic and reversible. Color-changing glass can adjust the transmittance through the lens color change, so that the human eye to adjust to the changes in environmental light, reduce visual fatigue, and protect the eyes.

1) sun-glasses can prevent the sun's ultraviolet radiation, ultraviolet light can harm the cornea

and retina. High-quality sunglasses can completely eliminate the exposure to ultraviolet light.

2) sunglasses can prevent glare. High-quality sunglasses can filter up to 97% of the light into the eyes to prevent injury.

3) sunglasses can avoid the exposure of glare, some surfaces can reflect a lot of light, and the resulting bright spots can disrupt vision or hide objects, high-quality sunglasses can use polarized technology to completely eliminate such glare.

4) sunglasses can eliminate certain frequencies of light, certain frequencies of light will blur vision, choose the precise color sunglasses, in a particular environment can eliminate certain frequencies of light daily hot news updated of real time.

This study is like giving sunglasses to the building facade, indoor office workers, the light seen through the glass curtain wall is the most applicable to people. Responding to different environments, to the building interior, to bring the same light environment, to improve the comfort of the building interior.

3.4 Glass materials of photochromic lenses

Photochromic lenses are lenses that become darker when subjected to a specific wavelength of light (usually ultraviolet light) and clearer when no longer exposed to this light source. Photochromic lenses can be made in glass or plastic, including polycarbonate. The color change is caused by the addition of silver chloride or other halides to the lens, which are transparent to visible light when not irradiated by UV light, but react chemically when irradiated by UV light and absorb part of the visible light to make the lens darker. This chemical reaction is reversible, so the lens will return to its original transparent state when it is no longer submitted to UV light.

3.5 Sunscreen vacuum glass can automatically change color to shade the sun

3.5.1 Principle of sun-proof vacuum glass

Tempered vacuum glass has better sun protection and heat insulation performance than the insulating glass we use every day. When the sun is set out through the window in summer, the LOW-E film inside the vacuum glass can effectively reflect infrared rays and block the heat

outside the window. You only are required to turn on the air conditioner for a short time every day to keep the room cools all day. It saves electricity costs and keeps users away from air conditioning diseases.

By compounding photochromic, thermodynamic and electrochemical functional layers, Longwang tempered vacuum glass itself has the function of automatic color change and sun shading, and the building facade is more concise and bright, and the cost is low, easy to clean and easy to maintain. At present, Longwang photochromic toughened vacuum glass has been successfully applied to Fujian Fenan's passive house project construction. The design of Fujian Fenan Experience Hall uses vacuum composite photo-thermochromic glass, which shows the transparent color in the morning and evening when the temperature is small, and turns blue when the temperature is high at noon to achieve automatic sun shading effect.

At present, China Longwang toughened vacuum glass is made of 0.2mm superior support to separate two pieces of glass and seal the edges of two glass panels with minimal temperature glass, and then expel the air in them. The vacuum between the glass is 10-4Pa, so the heat convection already does not exist, heat conduction is reduced to the limit, and the LOW-E layer reflects more than 95% of infrared radiation, so the heat between the inner and outer glass panels cannot be exchanged, achieving a good effect of sun protection and heat insulation.

3.5.2 Basic Features of China Longwang Tempered Vacuum Glass

Tempered vacuum glass consists of a 0.2mm distinguished support to separate the two pieces of glass and seal the edges of the two glass panels with low temperature glass, and then discharge the air in them. The vacuum between the glass is 10-4Pa, so heat convection no longer exists, heat conduction is reduced to the limit, and the LOW-E layer reflects more than 95% of infrared radiation, so heat cannot be exchanged between the inner and outer glass panels, achieving excellent thermal insulation. Tempered vacuum glass size: max 3000x2000mm; min 200x200mm; thickness 6~20mm.

Table 1 Tempered vacuum glass structure

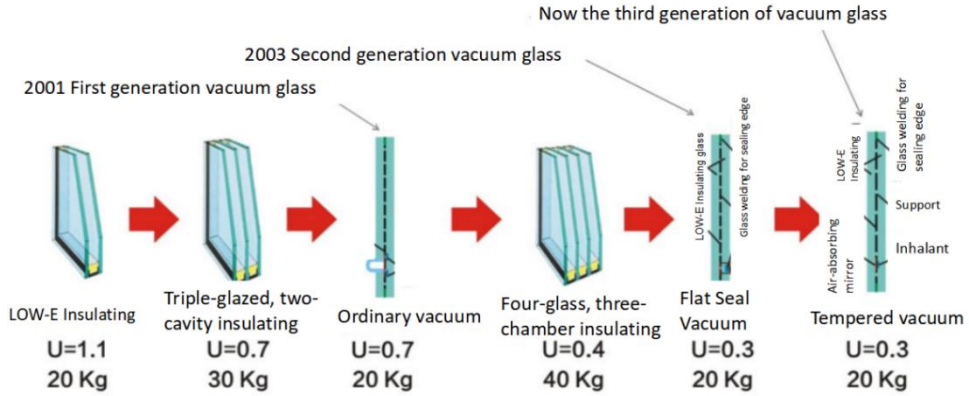
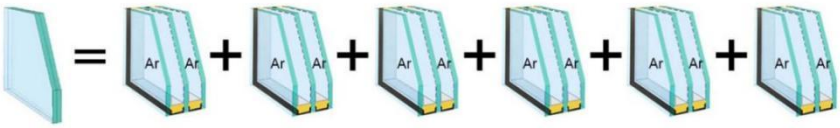
	Content
Structure Diagram	
Description	Tempered vacuum glass is made with tempered vacuum glass containing two pieces of triple silver LOW-E glass, the central heat transfer coefficient has reached 0.23. In other words, tempered vacuum is a piece of 8.2mm thick tempered vacuum glass. Insulation performance is more than three times the German 32mm thick triple-glazed two-cavity insulating glass. Life of tempered vacuum glass is 50 years, and the maximum life of German three-glass two-cavity insulating glass is 25 years, which means that the life is more than twice as long as that of Germany. 

Table 2 Tempered vacuum glass product parameters

No	Product Type	Structure	Thickness（mm）	Visible light transmittance（%）	Shading factor（Sc）	Heat transfer coefficientW/m^2.K	Soundproofing（dB）
1	Sunroom	TL6+0.4V+T6	12.4	49%	0.34	0.4	38
2	Passive room	TL6+0.4V+T6	12.4	72%	0.62	0.6	38
3	Composite hollow	TL6+0.4V+T6+12A+T5	29.4	44%	0.31	0.38	42

4	Glued compo site hollow	TL6+0.4V+T6+12A+T 5+0.76P+T5	35.16	44%	0.31	0.38	46
Rema rks	1.Glass thickness can be adjusted according to safety glass size standards and curtain wall design standards, commonly used thickness: 4mm, 5mm, 6mm. 8um;						
	2. The above parameters are for reference only, the actual supply color and parameters can be customized according to the design standard:						

3.5.3 Basic technical characteristics of tempered vacuum glass

Table 3 Tempered Vacuum Glass Features

Resistant to class 9 wind pressure	**Sun protection, temperature resistance**	**High sound insulation**
Half the thickness of insulating glass, wind pressure resistance that reaches the highest level of national standards; twice as dense as insulating glass. Tempered vacuum Glass is an ultra-thin material constituted by joining two pieces of tempered glass and titanium alloy under atmospheric pressure. It is placed under a high resistance to deformation under the action of external forces. Our industrial toughened vacuum glass technology improves its wind pressure resistance and strength, far better than ordinary vacuum glass and argon gas-filled toughened LOW-E insulating glass.	Reduce indoor glass temperature of 30 ℃, nano-silver film blocks infrared and ultraviolet rays, keeping family members away from air conditioning disease and protecting eyesight and skin. Installing Longwang tempered vacuum glass in the test room, the indoor and outdoor temperature of 100 was tested continuously for 385 days, the tempered vacuum glass was intact and unbroken, and the deformation was only 1%; the super high insulation performance remained unchanged. This shows that the tempered vacuum glass has been able to be used safely in different harsh environments around the world, and has become a really terrific glass.	Sound insulation capacity of LONGWANG tempered vacuum glass is preferable to ordinary insulating glass by 11 dB. The maximum sound insulation capacity of a single piece of toughened vacuum glass can reach 41 decibels. We can laminate hollow or laminated glass depending on the different needs of users to make super quiet transparent glass with very bright sound insulation performance in the world. Toughened vacuum glass keeps you away from noise hazards.
Protect your eyes, protect your fetus	**Suitable for all installation angles and altitudes**	**Ultra thin and light, no deformation, easy to open and close**

The human eye is extremely sensitive to ultraviolet radiation, which can cause itching, tearing, photophobia, redness, dark light maladjustment and other symptoms, leading to a variety of eye diseases. All aspects of our lives have been inseparable from electronic devices, which bring us convenience at the same time, but also bring electromagnetic radiation. This kind of electromagnetic radiation is still within the tolerable range for adults, but for the fetus in the pregnant mother's belly, there still be some effects. Longwang's electrostatic shielding tempered vacuum glass can absorb electromagnetic waves into heat energy and block them outside to maintain the healthy development of the fetus.	When the installation angle of insulating glass window is 30 degrees, its thermal insulation effect is reduced by 45%; when the installation angle is 60 degrees, its thermal insulation effect is reduced by 30% (the reason is: when the installation angle becomes smaller, the distance of gas convection from the hot side to the cold side becomes shorter, resulting in faster heat loss). Tempered vacuum glass, whether installed in the skylight of the roof or any other position, its thermal insulation performance does not decrease with the change of the installation angle.	The 12mm Longwang tempered vacuum glass is much lighter and thinner than 20~50mm center control glass, which requires less structural frame material and hardware components, reducing the cost of doors and windows curtain wall by about 50%. The windows are hard to say and deform, and have a longer service life. Elderly people and children can easily open and close the windows to ensure the security.

Low temperature welding

Tempered vacuum glass adopts low melting point technology, aerospace grade welded glass sealing edge, the same expansion rate, no air leakage, 50 years life. The glass pivot point is placed by automatic machine, and the glass is automatically clamped when vacuum is drawn, with vacuum degree of 10-4Pa.

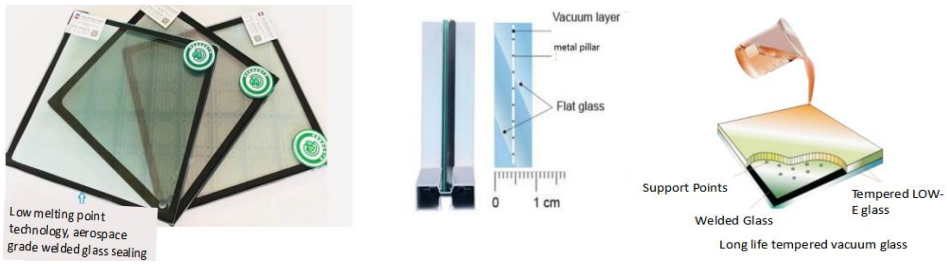


Figure 3. Tempered vacuum glass structure

Long life, resistant to condensation

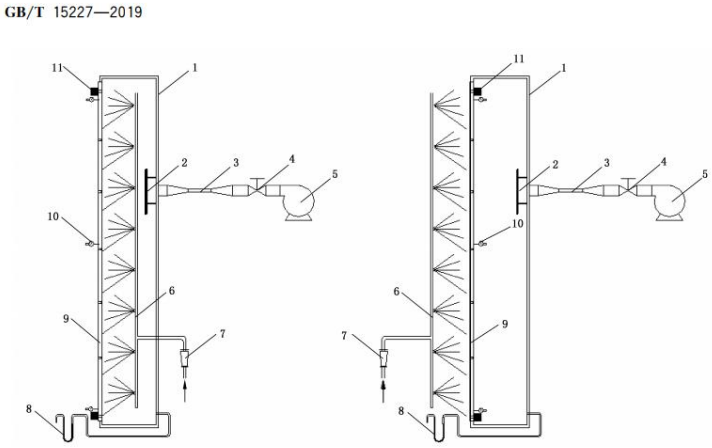
Aerospace-grade welded glass and tempered glass block gas leakage through the potent combination of chemical bonding. 50 years of high vacuum, perfectly retaining the low-radiation energy-saving activity of nano-silver film; avoiding the drawbacks of gas leakage of organic adhesive and metal sealing, eradicating the worldwide problem of oxidation failure of low-e glass. Past US IGCC certification. Dew condensation temperature is less than -50.

Cost effectiveness:

Tempered vacuum glass is compared with the world's strongest German triple-glazed two-cavity insulating glass, which is a very cost-effective window glass product in the world. German triple-glazed two-cavity insulating glass contains two pieces of triple silver LOW-E glass, both hollow layers are filled with argon gas, both hollow layers are sealed with super warm edge strips, and its central heat transfer coefficient K value can only reach 0.7 in the best state.

4. Test

The existing curtain wall is installed as shown in the figure, and the safety of the current glass curtain wall is measured.



A）Internal spray detection device

B）Outward spraying detection device

* Description 1 a pressure box; 2 an air inlet baffle; 3 an air flow measurement device 4 a pressure control device; 5 an air supply device; 6 a drenching device; 7 a water flow meter; 8 a differential pressure meter; 9 - test pieces; 10 a displacement meter; 11 a mounting cross frame.

4.1 Experimental Requirements

(1) the installation of the curtain wall should be fixed on the support structure with sufficient stiffness and strength, the installation of cross-frame deflection value should not exceed 1/1000 of its length and should not exceed 5mm under the maximum test pressure differential. Test process should ensure that the test piece is firmly installed, should not produce tilt and deformation, while ensuring the normal use of the test piece can be opened.

(2) wind supply equipment should have the ability to impose positive and negative two-way pressure difference, pressure control device should be able to regulate the stable airflow, and can provide a stable 3s ~ 5s cycle of fluctuating wind pressure, fluctuating wind pressure wave peak, wave valley value should meet the testing requirements.

(3) spraying device should be able to not less than 4L / (m - min) the amount of water sprayed uniformly to the outdoor surface of the test piece, the nozzle should be arranged, uniform, the distance between the nozzle and the test piece should be equal; device should be able to adjust the amount of water sprayed, and measures to ensure the uniformity of the amount of water sprayed.

4.2 Airtight performance testing

(1) test preparation before the test, the test piece should be opened and closed no less than 5 times, and finally closed tight.

(2) testing procedures

When the project on the airtightness testing pressure requirements, the testing pressure can be based on the engineering design requirements of the pressure to pressurize, the testing pressure sequence is illustrated in figure 3.

* the pressure required by the design of the project should take into account the

meteorological conditions of the project location, building characteristics, indoor air conditioning system and other factors to determine

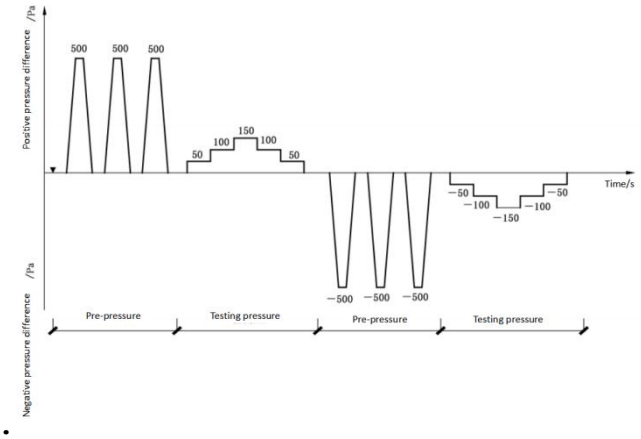


Figure 4. Schematic diagram of the pressurization sequence of the graded test

*: The symbols in the figure indicate that the openable part of the test piece is opened and closed not less than 5 times.

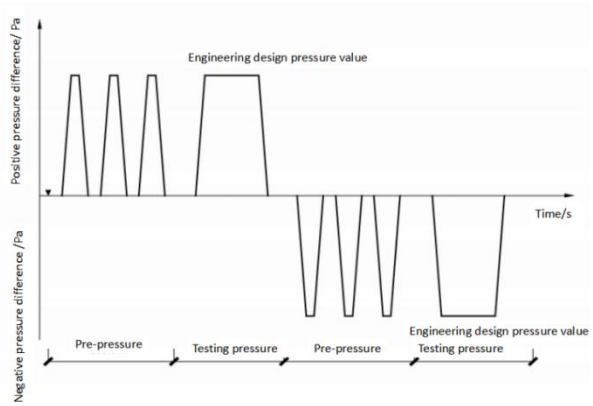


Figure 5. Diagram of pressurization sequence of engineering testing air tightness performance

*: The symbols in the figure indicate that the openable part of the test piece will be opened and closed not less than 5 times.

4.3 Pre-pressurization

Before the positive pressure pre-pressurization, open and close all the openable parts of the test piece in 5 time, and finally close them tightly. In the positive and negative pressure detection before the application of three pressure pulses respectively. The absolute value of the pressure difference is 500 Pa, the loading speed is about 100 Pa / s. The pressure

stabilization time is 3s, and the pressure relief time is not less than 1s.

4.4 Detection of infiltration volume

(1) The determination of additional air permeability q1

A. fully seal the test piece at the openable gap and inlay gaps or seal the exposed part of the box.

B. In accordance with 4.2 pressurization sequences, each level of pressure should not be less than 10s, first step by step to add explicit pressure, then step by step to add negative pressure. Recording air permeation detection value at all levels.

c. Pressure box openings for fixed size, additional air infiltration should not be higher than 50% of the test piece air infiltration, pressure box openings for non-fixed size, additional air infiltration should not be higher than the test piece air infiltration, otherwise, the use of colored smoke or tracer gas to check the leakage site, and after the sealing process to re-test.

2) supplementary air permeability and fixed part of the air permeability and the sum of 9g determination of the test piece on the test piece can be opened part of the opening gap after sealing for testing. The testing procedure is the same as b.

3) The determination of the total air permeability Q: test after removing the sealing measures added to the test piece. The same test procedure as b.* Allow the (3) (4) test order to be adjusted.

5. Detection Data processing

5.1 grading test data processing

5.1.1 Calculate the average value of the two additional air permeation detection values , the average value of the sum of the two additional air permeation quantities and the fixed part of the air permeation quantity , the average value of the two total air permeation detection values q in the process of pressure boosting and pressure lowering of the positive pressure test, respectively, and convert them into standard states according to formula (1) to formula (3):

$$q' = \frac{293}{100.3} \times \frac{\overline{q_1} \cdot P}{T} \quad \text{..... (1)}$$

$$q' = \frac{293}{100.3} \times \frac{\overline{q_{fg}} \cdot P}{T} \quad \text{.....(2)}$$

$$q' = \frac{293}{100.3} \times \frac{\overline{q_z} \cdot P}{T} \quad \text{.....(3)}$$

q' — Additional air infiltration values in cubic meters per hour at standard conditions(m/h);

q_{fg}' — The sum of the additional air infiltration and the fixed part air infiltration in cubic meters per hour in the standard condition (m^3/h);

q_z' — Total air infiltration value in cubic meters per hour in standard condition(m/h);

p — The test room air pressure value, in kPa(kPa);

T — Test chamber air temperature values at the time of testing, (K)。

5.1.2 The air permeation q of the specimen as a whole (including the openable part) at a pressure difference of 100 Pa, calculated: Press type

$$q_z = q_z' - q_f' \quad \text{.....(4)}$$

Where:

q, a standard state of the test piece as a whole (including the openable part) air infiltration volume, the unit is cubic meters per hour (/ h).

100 Pa pressure difference can be opened part of the air infiltration calculated by the formula:

$$q_k = q_z' - q_{fg}' \quad \text{.....(5)}$$

式中:

q_k - Air infiltration value in cubic meters per hour (m/h) for the openable portion of the standard condition.

Air infiltration per unit area under 100 Pa pressure difference ' value

is calculated according to equation (6):

$$q_A' = \frac{q_S}{A} \quad \text{..... (6)}$$

Where:

q_A' - Air infiltration per unit area, cubic meters per square meter per hour [$m^3/(m^2 \cdot h)$];

A - Specimen area, in square meters (m^2)。

5.1.3 Under the action of 100 Pa pressure difference, the air infiltration volume qi' value of the open part per unit open seam length

Calculated according to equation (7):

$$q_1' = \frac{q_k}{l} \quad \text{..... (7)}$$

Where:

q_1' - air infiltration volume per unit opening seam length in cubic meters per meter per hour [m^3 /(m • h)];

5.1.4 The results of the negative pressure test are calculated in the same way, according to formula (1) to formula (7), respectively.

5.1.5 by 100 Pa test pressure difference under the calculated value of q_A' value or $\pm q_1$' value, respectively, according to the formula (8) and formula (9) converted to the corresponding value of 10 Pa pressure difference $\pm q_A$ value or $\pm q_1$ value. The $\pm q_A$ and $\pm q_1$: values of the specimen are used to determine the respective levels by area and by seam length, and the most unfavorable level is used for grading.

$$\pm q_A = \frac{\pm q_A'}{4.65} \quad \text{..... (8)}$$

$$\pm q_1 = \frac{\pm q_1'}{4.65} \quad \text{..... (9)}$$

Where:

q_A - 10 Pa pressure difference, unit area air infiltration value in cubic meters per square meter per hour [$m^3/(m^2 \cdot h)$];

q_1 - 10 Pa pressure difference, unit open seam length air infiltration value in cubic meters per hour [m^3/(m • h)]

Comprehensive analysis of the above analysis results for comparative analysis can be concluded that without changing the building, the use of tempered vacuum glass to increase the natural lighting inside the building at the same time can be with the seasonal changes and changes in light, making the best natural lighting effect of the office building interior. So for the safety of the current glass curtain wall of high-rise buildings can be done to the following optimization design modifications, you can change the building glass curtain wall is replaced with toughened vacuum glass, through this test, the safety can be guaranteed.

6. Conclusion

This study is to address the functional requirements of the office building, the people-oriented, personal comfort requirements of the building console transformation: and focus on saving resources and energy and environmental protection of the building details and technology transformation.

The main purpose of this study is to improve the safety of the glass curtain wall and to improve the artistry of the building. 1. The test results show that the glass curtain wall does not fall off under pressure and remains within the safety range. 2. The use of color-changing tempered glass for the building facade allows the light of the interior environment to not change significantly with the seasonal changes outside. 3. To allow the light environment inside the office building is the most suitable for people's needs. At the same time, it can reduce the energy consumption caused by the heating and cooling effect of air conditioners and other equipment.

Making use of natural lighting not only saves electricity, but also allows people working in it to feel close to nature. Artificial lighting is often in the realization of natural lighting is more difficult to achieve the case, with the help of tools to achieve indoor lighting. Office space should have ample natural lighting, if natural light can enter the interior of the office space, it can enhance the quality of the indoor environment and improve the comfort of people. Therefore, although artificial lighting meets the lighting requirements, people also want to work in an office space with natural lighting, so that people have a psychological contact with

the natural environment.

In the future, glass curtain wall buildings will still exist and are also typical representatives of urban architecture, the degree of urban development is a reference basis for the development of new glass materials technology when it comes to the development of urban architecture can be better development possible.

References

[1] Walkenhorst O, Luther J, , & Timmer J. (2002). Dynamic Annual Daylight Simulations based on One-hour and One-minute Means of Irradiance Data. Solar Energy, 72(5), 385-395.

[2] Building Daylighting Design Standard, GB50033-2013, Ministry of Construction, People's Republic of China, 2012

[3] Reinhart C F. (2002. Effects of interior design on the daylight availability in open plan offices . Proceedings of the ACE3 2002 Summer Study on Energy Efficiency in Buildings, Pacific Grove, USA

[4] Reinhart C F, & Walkenhorst O. (2001). Dynamic RADIANCE-based Daylight Simulations for A Full-scale Test Office with Outer Venetian Blinds . Energy & Buildings, 33(7), 683-697.

[5] M-C Dubois， K Flodberg（2013） . Daylight utilisation in perimeter office rooms at high latitudes: Investigation by computer simulation, Lighting Res. Technol, 2013; 45: 52 –75

[6] Christoph F. Reinhart, Jihn Mardaljevic, Zack Rogers. Dynamic Daylight Performance for Sustainable Building, Uneversion de ce document se trouve dans: Leukos, v.3, no.1, July 2006, pp.1-25

[7] L. Roache, E.Dewey, P.Littlefair,Occupant reaction to daylight in offices, Lighting Research and Technology 32 (3) (2000)

[8] Reinhart CF, Effects of interior design on the daylight availability in open plan offices: Proceeding of the ACEEE Summer Study on Energy Efficient Building