A study related to the use of natural light in the biophilic design of traditional architecture in high-rise buildings

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Abstract. The harmonious concept of biophilic design is currently receiving a great deal of attention in the field of architecture, especially in response to the growing design of living environments, which reflect new forms of architecture that are more relevant to today's society. Open questions and controversies about the conceptualization and treatment of "harmony with nature" remain in practice and research. The combination of modern technology and tradition makes architecture more applicable to today's times.[10] This study explores biophilic design as a theoretical framework for explaining "harmony" in modern architecture through a literature review and actual restoration of traditional Chinese buildings. This study is about: (1) the concept and emergence of biophilic design (2) the five aspects of biophilic design in terms of material, structure, ventilation, landscape and daylighting that contribute to the realization of the goal of sustainable architecture (3) the key design elements of biophilic design, and so on. This review identifies and compares the key frameworks of biophilic design and explains their main concepts. The results show that natural light in biophilic design is healthier for the people who live there. In addition, research on the future development of buildings with more habitable spaces for people is made available to a critical direction for practice.

Keywords: Biophilic design, Restoration of old buildings, Development of architecture, Design of living environments, New forms of architecture

1 Introduction

Nowadays, urban high-rise buildings are more and more developed, but too unified architectural form, and no temperature. In contrast, in the past, architectural art was reflected in a variety of forms, with a quality of life and full of life.[15]In the concept of pro-biotic design, pro-biotic is "an innate emotional belonging of human beings to other living beings", in which "innate tendency" represents "inherited" characteristics; at the same time, as a kind of "genetic" characteristics; at the same time, as a kind of "genetic" characteristics, it is a kind of "genetic" characteristics. Characteristics"; at the same time, as a "learning rule", it provides an illuminating perspective for understanding nature[2]. Traditional buildings are many for living spaces improving the

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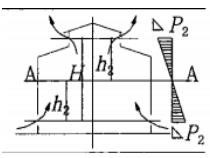
comfort of outdated buildings without losing their own architectural qualities. New buildings may be in disrepair or unable to adapt to different environments, we improve and optimize the comfort of the living environment with modern living standards. It is important to combine the advantages of modern technology with the essence of tradition to make our homes better.[1]

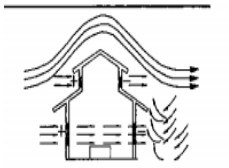
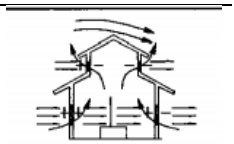
The design concept of this study is to improve the living environment issues, and the important factors that reflect an environmentally friendly remodeling project should be given special attention. Traditional buildings with natural light from good natural ventilation can provide a comfortable and pleasant space while significantly reducing electrical energy consumption for heating and cooling.[12] Low-carbon living does not sacrifice personal comfort or incur higher costs; on the contrary, it makes our homes better and healthier. Biophilic design maximizes social development by utilizing resources and reducing resource waste. At a time when material life is improving, to successfully draw spiritual life to comfort, more applicable with the people themselves, is for the future of the building can be developed direction.[5]

2 Related theoretical studies

When the current state of traditional Chinese architecture is repaired or renovated, the comfort of traditional buildings is considered to be improved and optimized by modern living standards, without losing their own architectural qualities. [6] For this study, the modern living environment is viewed from the perspective of biophilic design.[16]

Table 1. Types and principles of building ventilation

Ventilation Type	Principle	Form
Hot press ventilation	Due to the temperature difference, indoor and outdoor density difference, along the vertical direction of the building wall pressure gradient, that is, the use of indoor and outdoor air temperature difference caused by the difference in air density and the height difference between the air inlet and outlet to achieve ventilation, when the wind blows towards the building, due to the blockage of the building, which is commonly known as the " chimney effect".[13]	

Wind pressure ventilation	When the wind blows towards the building, it will generate positive pressure on the windward side of the building due to the blockage of the building; the air flow around the sides and back of the building will generate negative pressure at the corresponding location. The air flow from the windward side to the interior, and then from the interior to the leeward side, forming ventilation.	
Hybrid ventilation	In the parts of the building with small depth, more use of wind pressure to direct ventilation, while the parts with larger depth, more use of thermal pressure to achieve the effect of ventilation.	

3 Methodology and process of the research

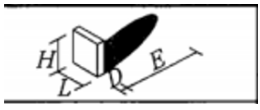
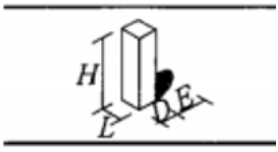
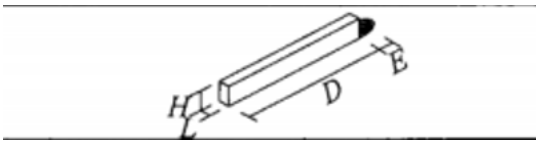
3.1 Building natural ventilation

(1) Natural building ventilation refers to the use of indoor and outdoor air temperature difference between the building caused by the thermal pressure or density difference and wind pressure to promote indoor and outdoor air flow, to achieve the role of ventilation and air exchange. It does not consume mechanical power, and can produce good ventilation under suitable conditions. The judicious use of natural ventilation technology in residential design is conducive to saving energy, increasing indoor comfort and improving indoor ecological environment.[9][14](see table 1).

(2) Relationship between building monolithic shape and ventilation

The three-dimensional ratio of the building has a greater impact on the backwind vortex area and wind pressure distribution. The larger the windward area, the larger the backwind vortex area and the lower the wind speed.[19] (see table 2).

Table 2. Relationship between building form and ventilation

		
L=H, D/H Very small	*L=H, D/H> 1*	*L=H, D/H* Very wide
		
L=D, H Very high	*L=H, D/H> 10*	

3.2 Ways to improve indoor air quality

(2) (1) Using green materials;[8]A scalablehigh-porosity wood for sound absorption and thermal insulation.[17]

(2) Enhancing indoor ventilation and air exchange; [4]

(3) Air purification: adsorption technology, filtration technology, low-temperature plasma, nano-materials, membrane separation, high-voltage electrostatic devices and other technologies;[15]

(4) fresh air device, fresh air device is an independent air treatment system that filters and purifies fresh outdoor air without opening doors and windows for ventilation and delivers it to the room through a piping system, while excluding turbid and harmful indoor air. It can effectively purify the particulate matter (PM2.5, PMlO) in the outdoor air and avoid indoor airflow disturbance;[18]

(5) Indoor planting of green plants.[7]

3.3 Terms and definitions

(1) visible light transmittance visible light transmittance

In the visible spectrum (380 nm ~ 780 nm) range, CIE D65 standard illuminant conditions, the CIE standard visual function for the reception of the conditions of the transmittance of light flux and the ratio of incident light flux. Technical requirements ≥ 0.40

$$\tau_{\gamma} = \frac{\sum_{380}^{780} \tau\left(\lambda\right) D_{\lambda} V\left(\lambda\right) \Delta\lambda}{\sum_{380}^{780} D_{\lambda} V(\lambda) \Delta\lambda} \tag{1}$$

$$\text{in } \tau(\lambda) = \frac{\tau_1(\lambda)\tau_2(\lambda)}{1-\rho_1^{'}(\lambda)\rho_2(\lambda)} \tag{2}$$

- τ_1 Spectral transmittance ratio on the first side
- $\rho_1^{'}$ Spectral Reflectance Ratio of the Second Surface
- τ_2 (λ) Spectral transmittance ratio on the third side
- $\rho_2(\lambda)$ Spectral reflectance of the third plane

(1) Direct solar transmittance ratio

Wavelength range 300 nm ~ 2 500 nm solar radiation through the object being measured and the ratio of incident radiation flux.

Direct solar transmittance ratio. The following calculation is used:

$$\tau_{\mathrm{e}} = \frac{\sum_{300}^{2500} \tau\left(\lambda\right) S_{\lambda} \Delta\lambda}{\sum_{300}^{2500} S_{\lambda} \Delta\lambda} \tag{3}$$

Where: τ direct solar transmittance ratio of the specimen; λ wavelength; τ (λ) spectral transmittance ratio of the specimen; S relative spectral distribution of solar radiation; Δλ wavelength interval; S relative spectral distribution of solar radiation S. and the product of the wavelength interval △λ. (see table 3 and table 4).

Table 3. Test Result

Sample Size	Calibrated emissivity	standardized emissivity	factor
6mm	0831	0.884	0.941

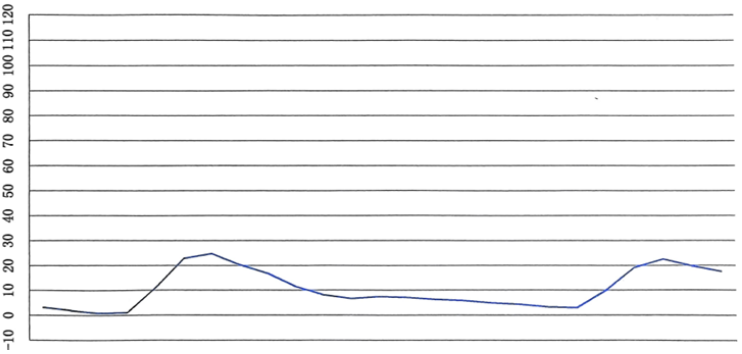


Table 4. Test results table

Wave length	Transmission (reflectivity) (%)	Wave length	Transmission (reflectivity) (%)	Wave length	Transmission (reflectivity) (%)	Wave length
5.5um	3.15	9.2um	22.86	11.8um	8.22	14.8um
6.7um	2.04	9.7um	24.77	12.4um	6.71	15.6um
7.4um	0.90	10.2um	20.31	12.9um	7.47	16.3um

Basic Reference Values.

- 1) Thermal resistance coefficient of the glass: r = 1m·K/W;
- 2) Corrected emissivity of the glass surface ε_1 = 0. 175;
- 3) Corrected emissivity of the glass surface ε_2 = 0. 837.
- 4) Temperature difference between the inner and outer surfaces of the insulating glass ΔT = 15 K;
- 5) the average temperature of the insulating glass T_a = 283K;
- 6) Constant σ= $5.67\times10^{-8}/\left(\mathrm{m}^2\cdot\mathrm{k}^4\right)$;
- 7) Heat transfer coefficient of outdoor surface h= 23. OW/(m2·k);
- 8) Indoor surface heat transfer coefficient hi= 8. OW/(m2·k).

3.4 Indoor sun light

Biologically effective indoor daylight defines:

- intensity of eye illuminance.
- color spectrum of the light.
- direction of the light.
- dynamism of daylight.

This system is called homeostasis in physiology. (HOMEOSTASIS) Every time dopamine is stimulated, it is at a low point again. The multi-stimulation of the present period in a multi-recreational environment causes even lower lows. That is, in over-stimulated dull and dry. Such as smoking and drinking, swiping cell phones and other behaviors. Stanford professor Anna lemke says, in more developed countries have a higher suicide rate, any pleasure has a price. Our brains are receiving high stimulation, and the baseline of dopamine balance has been lowered. That's why we can't design our things in an environment of extreme convenience. The way to break this cycle is to raise the dopamine baseline.[3]

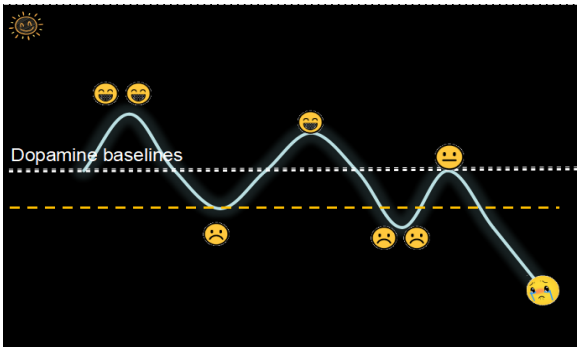


Fig. 1. When exposed to sunlight releases dopamine with

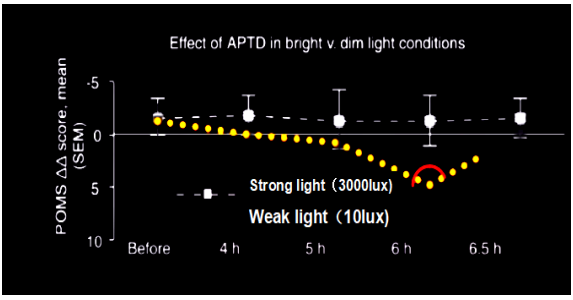
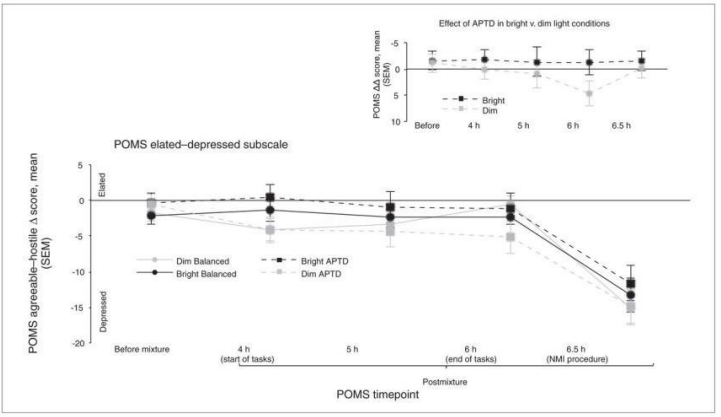


Fig. 2. Daylight intensity release and dopamine

According to the literature in 2021 when exposed to daylight a large amount of dopamine is released and can activate two circuits: while in a dim environment, it is

greatly reduced and only a small amount of dopamine is released and only one receiving circuit is activated.[11] As showing in Fig. 1 and Fig. 2.

Table 5. Light test results

Light test results


The test environment was a window less, temperature-controlled and soundproofed isolation suite, unaffected by external time cues, ensuring consistency between sessions. The dopamine was lowered by medication in the experiment, and only in dimly lit environments did people experience negative emotions such as depression. Exposure to daylight for an average of 10-30 minutes per day, which is immediately raised the dopamine baseline western line allows us to quickly regain motivation method. Applied in the architectural design, ensuring 10-30 minutes of direct sunlight into the room every day will greatly enhance the comfort of the living environment. Just like the courtyard space that ancient buildings have, the present is necessary. There are more opportunities for contact with nature. (see table 5).

Residential natural lighting

Residential layout: When planning the layout of residential groups, we should fully consider the lighting of each residential building, control the height of each residential building, the volume ratio and the distance between buildings to meet the lighting requirements, and the main lighting surface of each household should have a good lighting orientation.

4 Conclusions

Biophilic design in architecture is a design concept that returns to the essence of life in modern society. This study strengthens the development of spatial design to provide solutions, including 3 aspects: (1) the concept and generation of pro-biotic design (2) pro-biotic design in the material use of green thermal insulation, structural use of building thermal pressure or density difference resulting from the wind pressure to

promote indoor and outdoor air flow, improve ventilation landscape daylighting, etc. will help to achieve the goal of sustainable buildings (3) the key pro-biotic design design element is light, daylight releases a large amount of dopamine, and ensuring direct sunlight for 10-30 minutes a day into the interior will greatly improve the comfort of the living environment, increase more opportunities for direct contact with nature, and improve the sense of well-being of the occupants. This review identifies and compares key frameworks for biophilic design and explains their main concepts. The results show that the built environment in biophilic design is healthier for the people who inhabit it. Reflecting the harmonious elements of nature and architecture from the outside in, the impact of biophilic design on human factors in architecture is manifested in materials, light and ventilation. Human beings can obtain comfort, health and relaxation through the connection with nature. In addition, it provides a practical and decisive direction for future research on the development of architecture for more human-friendly living spaces.

4.1 Declaration of competing interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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