Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 169 (2016) 125 – 132

Procedia Engineering

www.elsevier.com/locate/procedia

4th International Conference on Countermeasures to Urban Heat Island (UHI) 2016

The Analysis of Reactive Factors between Architectural Envelop Condition and Urban Microclimate

Dexuan SONG [a,*], Shanshan HAN [a]

[a]*College of Architecture and Urban Planning Tongji University,*
Key Laboratory of Ecology and Energy Saving Study of Dense Habitat, 1239 Siping Road, Shanghai, 200092,P.R. China

Abstract

High-density has become an inevitable tendency of urbanization. Contemporary buildings grow higher and denser; high-rise and high dense buildings have become the main method of newly-built buildings. The reaction between street canyon and urban microclimate should be studied scientifically. The buildings envelop factors include the material properties such as smoothness, albedo, while the envelop morphology factors include entasis, porosity, stepped podium and stilt buildings. These building factors studies are conducted to clarify the effects of building geometries on urban microclimate, as well as the reaction among the factors themselves. The multiple-factor study result provides effective mitigation strategies to alleviate UHI effect and to conduct proper environment control.

Peer-review under responsibility of the organizing committee of the 4th IC2UHI2016

Keywords: high-density; building envelop; microclimate; reactive factors

1. Introduction

Responding to climate change is one of the main reasons for architecture. Based on the increasingly close interaction between architecture and climate resources, the ecological design method which aims at improving the urban microclimate environment has gradually become the social focus. With the increasing of global warming and urban population, the UHI (urban heat island) impact has become a global environmental problem. Heat Island Effect is defined as phenomenon of difference in temperature that urban temperature is higher than suburban temperature because of the different building density, materials and traffic conditions. The heat island effect can be characterized by heat island intensity, the temperature difference between two points. It is common throughout the year, but summer

* Corresponding author. Tel.: +86-130-4465-1877.*E-mail address:* dxsong@tongji.edu.cn

Peer-review under responsibility of the organizing committee of the 4th IC2UHI2016
doi:10.1016/j.proeng.2016.10.015

hazards are rising prominently. High temperatures will not only reduce people's comfort and increase the probability of heat stroke, but also increase the air conditioning energy consumption of the building which will further increase the heat island intensity, to the urban environment limitless vicious circle. This paper starts from the perspective of architectural design, i.e. through the multi-dimensional analysis of architectural envelop, to find materials, form and other factors on the impact of the heat island effect and compensation strategy. It is expected that the climate adaptive architectural methods can give effective mitigation strategies to alleviate UHI effect on urban lives, and to design healthy urban environment and sustainable development.

2. The High-Density Situation and UHI Effect in Shanghai

2.1. The high-density situation in Shanghai

In recent years, along with the rapid development of China's urbanization, Shanghai as the most important economic center, is ushered in the explosion of population and urban construction. At the end of 2013, the permanent resident population has reached 24.15 million, and the construction area has been 1.1 billion m², almost 3 times as in 2000. Buildings with more than 8 floors added up to 36,000, one-third of all types of buildings. Due to the economic, social and natural environment, the distribution of population and architecture is extremely unbalanced. The population density in each district of Hongkou, Huangpu, and Jingan has exceeded 30,000/km². The population density of Hongkou even reached 35,757/km², 60 times as Chongming. Huangpu plays an important role as the economic center in Shanghai, covers an area of 20.46 km². By the end of 2013, the resident population reached 691,000, the population density reached 33,803/km², and floor area ratio was 1.72. Buildings with more than 8 floor area came to 22 million m², about 61.2% of total construction area. Mixed-use, office and high-rise buildings are located in Huangpu District. A variety of architectural forms constitute the waves of the city skyline. This political, cultural and economic center district only takes 3‰ area of Shanghai. The population and building density conditions clearly display the flourish and prosper under high-density surroundings [1].

2.2. The UHI effect in Shanghai

High density as the inevitable result of urbanization brings great changes to urban spaces: the excessive concentration of central population, the extension of urban space height, and the narrowing of urban spatial distance. High-density urban environment not only causes the change of the underlying surface of the city, but is also accompanied with the increase of architectural heat storage and artificial heat radiation. The secondary heat release from urban construction (i.e. the release of heat storage from the environment) and poor heat dissipation are ones of the main causes of UHI effect.

Since 1990s, the summer temperature in Shanghai showed a gradual upward trend. The temperature difference between the suburbs and the city increased significantly. Meteorological data shows that in recent years the annual average heat island intensity of Shanghai is more than 1°C. The number of UHI days are more than 80% of the total year. According to present literature, the urban heat island is not existed in a uniform distribution, but shows a significant positive correlation with the building and the population density distribution. The center of heat island in Shanghai is usually located in the high-density area of building and population. The downtown of Shanghai is the center of high temperature. The northwestern suburbs of Baoshan, Jiading, and Qingpu make up the second-high temperature region of Shanghai City. Southeastern outskirts of Jinshan, Fengxian and Nanhui are located in the low temperature region as they are influenced by the land and sea waterfront topography. Wind is the most important meteorological factor affecting the intensity of heat island effect in the Shanghai area. The urban heat island in Shanghai is shown mostly in area with 8-floor-and-above buildings which indicates that large scale and high intensity urban construction is the main cause of the urban heat island effect.

Due to the different solar heat absorption, reflection and water permeability, different types of land use will also have different impact to the heat island intensity. The largest influence to UHI intensity comes from residential land, followed by road and square, and lastly by factory site. The residential buildings in heat island area generally have high architectural density and narrow spaces between buildings. The building distribution cannot form fluent