International Journal of High-Rise Buildings
December 2017, Vol 6, No 4, 323-326
https://doi.org/10.21022/IJHRB.2017.6.4.323

International Journal of
High-Rise Buildings
www.ctbuh-korea.org/ijhrb/index.php

Sustainable Design and Its Cost: Case Study of Nanning China Resources Tower

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Abstract

Sustainability is becoming more and more important in our everyday lives. Thus, it is apparent that more sustainable initiatives are incorporated in a building design concept to reduce operation costs and environmental impacts. However, will the construction cost go up if the building is going green - especially if it is a tall building? This is the question on everyone's mind. In the following paragraphs, we will look into a case study of a skyscraper in Nanning, China. That 411-metre skyscraper, Nanning China Resources Centre East Office Tower, is currently under construction. Designed to LEED-CS Gold standards, the building has adopted a number of sustainable design elements and operation practice, which indeed only accounts for a small percentage of the total construction cost.

Keywords: Tall building, Sustainable design, LEED, Green features, Operation cost

1. Introduction

The construction market in China is huge where half of the worldwide new buildings constructed annually are there. According to the year-end report from the Council on Tall Buildings and Urban Habit (CTBUH) in 2016, there were 128 buildings over 200 metre high completed around the world of which 84 located in China.

Due to the increase in urbanization and the national commitments in conserving resources and reducing greenhouse gas emissions, China has steadily introduced more green features in its massive construction market. In early 2006, a 3-star China National Green Building rating system were launched, which would cover the recommendations and ways for implementation of environmentally friendly and energy efficient construction from design stage to operational stage.

Besides, promotion of green construction is one of the prime objectives in China's 13th five year plan. On 1st January 2015, China's Ministry of Housing and Urban-Rural Development (MOHURD) approved the "Assessment Standard for Green Building in China" in conjunction with the national standard (Number in GB/T50378-2014) which replaces the previous standard (GB3T50378-2006). The "Assessment Standard for Green Building in China" evaluates the star rating based on eleven categories, including Basic Requirements, Land Saving and Outdoor Environment, Energy Saving and Energy Utilization, Water Saving and Utilization, Material Saving and Material Resource Utilization, Indoor Environment Quality, Construction Management, Operation Management and Promotion, and Innovation.

In addition, the LEED certifications are becoming more and more popular in China. Since the first building in China achieved the LEED Gold certification in 2005, the numbers of green buildings with the LEED certifications in China have grown exponentially over the last decade, and buildings with green features have become increasingly predominant over the last few years. It is estimated that, by 2020, the construction floor area of green buildings in China will reach five million square metre or above, which will be five times more than the figures in 2013.

2. A Sustainable Building

A sustainable building or a green building is the outcome of a design concept which focuses on the increase in the efficient use of resources such as energy, water and materials. Besides, it reduces the impacts of buildings on human health and environment during the life cycle of buildings by carrying out improvements in preparation, design, construction, operation, maintenance and removal. These elements constitute the basic criteria for setting the different credit categories of the LEED rating system for which the LEED provides a framework for the project team to determine the aspects of sustainability with different levels of the LEED certifications.

The benefits of sustainable buildings can be generally categorized into environmental, economic and social aspects.

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2.1. Environmental benefits

Green buildings can reduce or eliminate the negative impacts on the environment by reducing the consumption of energy, water and natural resources.

Construction of green roofs can reduce energy use by insulating the buildings from heat penetration from outside which in turn reduce energy consumption in the air-conditioning system.

Water consumption can be reduced by using alternative sources such as rainwater, reducing water wastage through the installation of sanitary fittings with high water efficiency and reducing the contamination of the water resources by the installation of conservation systems that purify water and enable recycling.

In addition, taking steps to use fewer materials in the manufacturing process can help relieve much stress on our mother nature which then the occupants can benefit as well.

2.2. Economic benefits

There are loads of evidence showing that sustainable buildings provide financial benefits to building owners, operators and occupants. While designs with sustainable features may attract higher initial costs, their payback period is often shorter and the life cycle costs are somewhat lower than the costs of the traditional buildings.

2.3. Social benefits

Sustainable designs also bring forth social benefits which include improvements in the quality of life, health, and well-being, which are not just limited to the occupants of the buildings but the community and the society as well.

Sustainable buildings can be our homes, workplace or leisure space. Through an optimized system in temperature control and ventilation, we can create a good physical condition for human. On the other hand, studies show that buildings which maximize the use of natural light can consistently improve employees' satisfaction and productivity. So, by enhancing indoor and outdoor air quality, lighting and temperature control, sustainable designs can bring health and comfort to the users. In addition, exploiting our natural landscape aesthetically will minimize the utility development of our local infrastructure. As a result, there shall be a general improvement in our overall quality of life by affecting less of our natural environment.

3. Does Green Building Cost More?

Some people may think that a sustainable building will be more expensive to build. It is true if considering only the initial cost as there shall be additional costs for the design and construction of the green building. However, it shall be another scenario when the running cost has come into play having regard also to the energy cost saved because going green can conserve energy. A green building may cost more to build but will cost less to run.

In the following paragraphs, we would look into some green features adopted by our case study project, namely Nanning China Resources Centre East Office Tower (NCRC East Office Tower), a super high-rise building in China for which Rider Levett Bucknall is appointed as the cost consultant for the project.

4. Case Study

NCRC East Office Tower is a 411-metre, 87-story super high-rise building in Nanning, China, the capital of the Guangxi Province. It is situated at the heart of the city's Fengling District, along Minzu Avenue. The gross floor area of NCRC East Office Tower is about 220,000 m^2 above ground.

NCRC East Office Tower is a mix-used tower consisting of approximately 5,000 m^2 of boutique retail, 170,000 m^2 of Grade A office and 45,000 m^2 of luxury hotel. It will be connected to the shopping centre and buildings adjacent to the development through indoor and outdoor pedestrian corridors at the ground level and sixth floors respectively. Besides, it will be linked to the public transportation through underground connections at the basement level. NCRC East Office Tower is under construction and will be the tallest building in that region upon completion in 2019.

Similar to the increasing trend of green buildings in China, NCRC East Office Tower has been designed to achieve a 2-star rating according to the Assessment Standard for Green Building in China (GB/T50378-2014 version) and the LEED-CS Gold standard in which a number of notable sustainable features are adopted.

Based on the comments and recommendations by the Sustainable Consultant for NCRC East Office Tower, the following items are extracted for further elaboration in this paper.

4.1. Material Saving and Material Resource Utilization

4.1.1. Light Pollution

Buildings' light pollution includes light reflection by curtain walls, façade lightings and lightings of advertising, etc. With reference to the information from Wikipedia, light pollution is a broad term that refers to multiple problems, all of which are caused by inefficient, unappealing, or (arguably) unnecessary use of artificial light.

The effective ways to control buildings' light pollution include reducing the visual light reflectance of the building surfaces and being reasonable in the selection of lighting fittings, etc. Based on the Assessment Standard for Green Building in China (GB/T50378-2014 version), the visual light reflectance of curtain walls should not be greater than 0.2, and for NCRC East Office Tower, and Low-E coated glass (Low-E glass) is selected for the curtain walls in order to fulfill this requirement.

Low-E glass is a kind of glass plated with several layers of metals (including silver layers or metallic compounds).

It has a high visible transmission and high infrared reflectance which minimizes the amount of ultraviolet and infrared light that passes through the glass without compromising the amount of visible light.

4.1.2. High Yield Steel Bar Reinforcement

The Assessment Standard for Green Building in China (GB/T50378-2014 version) states that high yield steel bar reinforcement, with the strength of 400 MPa or above, can be regarded as one of the sustainable construction materials. On average, 12% saving in the total tonnage of steel bar reinforcement can be achieved by substituting 400 MPa high yield steel bar reinforcement for 335 MPa for which the latter is commonly used in the construction industry in China.

According to the design criteria from the Structural Engineer during the schematic stage, 400 MPa high yield steel bar reinforcement should be adopted for all structural elements for NCRC East Office Tower. From our measurements, about 65% of the total steel bar reinforcement for NCRC East Office Tower (both basement and tower portions) is 400 MPa. Based on a hypothetical calculation, more than 2,000 ton of steel bar reinforcement can be saved. However, on balance, we reckon that there should not be additional cost for earning the credit point for this item.

4.1.3. Reusable Construction Materials

Used construction materials, which can be reused for permanent works straight away or after simple synthesis/rejuvenation process or after recycling, can be counted as reusable construction materials. According to the findings from the Local Design Institute, the use of recyclable and reusable materials such as steel, wood, aluminum alloy, gypsum products, doors and windows, glass curtain walls, copper, etc. can be accommodated reasonably and practically for NCRC East Office Tower. So, there should not be additional cost for getting the credit point for this item as well.

4.2. Energy Saving and Energy Utilization

Energy efficiency is one of the most specific features for green buildings, especially energy constitutes a significant outlay of building operations. In order to reduce the operational costs, energy saving can be achieved through exploiting energy efficiency, particularly the air-conditioning and lighting loads amid providing a comfortable indoor environment.

4.2.1.Air-conditioning System

To optimize the energy systems of buildings, there are different requirements for achieving the coefficient of performance (COP) at industrial and state levels in China. The LEED rating system also provides a strong incentive to improve the efficiency of the air-conditioning system. In addition, based on the Assessment Standard for Green Building in China (GB/T50378-2014 version), additional marks can be obtained if the COP of air-conditioning systems can meet the required standards such as the Energy Efficiency Design Standard for Public Buildings (GB/50189). In general, the higher is the COP ratio, the lower are the operational costs.

For NCRC East Office Tower, the COP of the centrifuge sets is upgraded from 5.1 to 6.1 and the chillers with screw compressors from 4.3 to 5.9 in order to fulfill the Assessment Standard for Green Building in China and obtain the required marks. From our estimation, a total of additional cost of RMB 3,000,000.00 approximately would be incurred. Such additional cost includes all relevant expenses for upgrading the fan coils, water pumps and air exhausters, etc., and also represents approximately 30% of the total cost for the sustainable features of NCRC East Office Tower.

4.2.2. Lighting System

Researches find that daylighting can substantially improve indoor environmental quality and the productivity of workers and students, as well as reduce absenteeism and illness. On the other hand, divisional control, timing control, automatic inductive switch and adjustment for

illumination, etc. play a significant role in reducing lighting consumption.

For NCRC East Office Tower, all lighting systems at corridors, staircases, foyers, lobbies, open space and underground parking zones, etc. are equipped with the above mentioned energy-saving control measures to fulfill the requirements of the Assessment Standard for Green Building in China and to maximize the penetration of daylighting at the same time. In addition, the lighting systems at corridors, staircases, fan rooms and water pump rooms are upgraded to reach the target value of 3.5 W/m^2 for lighting power density, which is specified in the Standard for Lighting Design of Buildings (GB/50034). Also, to reach the target value of lighting power density mentioned, high-performance T5 fluorescent tubes and electronic ballets are also adopted in the office zone.

Moreover, to implement the energy-saving control measures during night time, NCRC East Office Tower adopts the design of automatic or manual non-emergency indoor lighting system, in which the original lighting density can be reduced 50% from 11 pm at night to 5 am in the morning. Meanwhile, the lighting power density for outdoor lighting in the night-time is also designed according to the requirements of ANSI / ASHARE / IESNA90.1-2010, which are stipulated in the LEED rating system.

From our estimation, a total of additional cost of RMB 2,000,000.00 approximately would be incurred for adopting the measures for energy saving and better energy utilization which represents approximately 20% of the total cost for the sustainable features of NCRC East Office Tower.

4.3. Water Saving and Water Resource Utilization

Water conservation is not only saving in end users' operational costs through reduced utility expenditures but also enhancing the recycling rate of water resources, reducing the volume of water supply from the public utility and volume of discharge of sewage.

Cooling towers for the central air-conditioning system consume large amount of water, at 30% or even 50% of the total water consumption of the whole building during operation. As such, a reduction of unnecessary water consumption in the cooling water system can bring profound improvement in water saving for the whole building.

According to the design brief at the schematic stage, non-traditional water resources have already been identified for use on the podium E&M floors of NCRC East Office Tower. For example, water collection tanks are put in there to collect the condensate water from the air-conditioning system and waste water from SPA and swimming pool. Such water collected, after filtration and sterilization, will be reused in cooling towers, water features at the landscaping areas and carpark cleaning. Furthermore, water saving laundry machines and sanity fittings at the hotel zone are also designed for water saving and better water resource utilization.

From our estimation, a total of additional cost of RMB 1,000,000.00 approximately would be incurred for adopting the measures for water saving and better water resource utilization which represents approximately 10% of the total cost for the sustainable features of NCRC East Office Tower.

5. Conclusion

There is a common perception that green buildings and the LEED certified buildings usually come with a higher capital cost. That may not be true as the cost of every single project varies widely from case to case. Taking NCRC East Office Tower as an example, the additional cost for obtaining the 2-star rating according to the Assessment Standard for Green Building in China (GB/T50378-2014 version) and the LEED-CS Gold standard only accounts for approximately 0.25% of the total construction cost.

So, will sustainable designs cost more? Definitely yes, but they will bring benefits as well. We foresee that green features will become a must in the future designs, rather than "value-added" items for the super high-rise buildings as well as all the new project developments.

References

Council on Tall Buildings and Urban Habitat, CTBUH Year in Review: Tall Trends of 2016.

Assessment Standard for Green Building in China (Standard No. GB/T50378-2014)

Web Resources, China - Construction and Green Building (https://www.export.gov/article?id=China-Construction-and-Green-Building)

Web Resources, The Federal Commitment to Green Building: Experiences and Expectations (https://archive.epa.gov/greenbuilding/web/pdf/fedcomm_greenbuild.pdf)

Web Resources, Christina, M. Webb (1999) Green Building: Public Opinion, Semantics and Heuristic Processing (http://etd.fcla.edu/CF/CFE0000600/Webb_Christina_M_200508_MA.pdf)