

# Living Wall Jungle the Concrete

墙上花园 童家林 编 殷文文 译





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# **Living Wall**

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## PREFACE 序言

Dear readers, whether you are a proprietor or an architect, an engineer, or even just a passer-by, and you have seen some green walls, in person or from images, perhaps from books, internet, perhaps from architect's renderings. You may ask yourself: Is it real? How to make it? What makes it success? I had the same questions five years ago! And I wanted to refer to some books for details.

There are some books about green wall; some are too difficult to understand, and others are too general, without enough information. When Ms. WU Yang invited me to write a book to summarise the green wall technologies and to introduce some green wall projects from different countries, I had no choice but to say YES. Personally, it is a book to conclude the last five years' work of green wall projects and research.

I would love to talk a little bit more about my story with green wall, if you allow. It was in the end of 2008, when doing internship with Paysagestion in Switzerland, I was looking for some inspiration from books; suddenly I came across Vertical Gardens, and I told myself: Voilà, this is exactly the new concept that I am looking for! In August 2009, I began to work with Beijing Greenlink Küsters, studying by doing the green roofs, until then I came to know that it was Patrick Blanc who invented the concept of vertical garden (Mur Vegetal, means vegetated wall in French). Then in October 2010, I was invited to see green wall projects in Hong Kong by Mr. John Yau. They have already built green walls in their office, both indoor and outdoor; I admired them very much. They invited me to work with them on the green walls, and I answered YES, without any hesitation.



Until end of 2012, I have designed and built more than 2500 m<sup>2</sup> green walls, huge sizes and small sizes; some are quite successful, some finally came to a failure. I have gradually understood the secrets of the green wall, but not all. In December 2012, I decided to visit the green walls by Patrick Blanc in Paris, to look at them as close as possible, to touch them, face by face. Parc Floral (1994, outdoor), Fondation Cartier (1998, outdoor),

亲爱的读者，不管你是业主还是设计师，或者你就是绿墙工程师，甚至你只是无意中看到这本书，你可能已经在什么地方见过墙体绿化，可能是书本上，互联网上，或者是设计师的图纸上。你会问：这是真的吗？这是怎么做出来的？有什么技术要点？我也一样，想从某本手册中找到一些技术数据作参考。

市面上已经有几本介绍绿墙的书籍，要么是英文，读起来很费劲，要么就是泛泛而谈，没有实际的技术要点。当辽宁科学技术出版社的吴杨找到我，说想出一本书，简单明了地介绍一下绿墙技术，并且展示一些实际项目，我欣然同意。这本书也算作对自己这5年工作的一个经验总结。

如果你还有耐心的话，我还想讲讲我和绿墙缘分。2008年年底，我在瑞士一家景观设计工作室实习，做方案的时候翻书找灵感，偶然翻到一本《垂直花园》，看到封面照片的时候，我就说：哇，这不就是我苦苦找寻的新概念吗！2009年，我到北京绿色链接库斯特工作，开始学习设计屋顶绿化，我才知道是帕特里克·布朗克这个人发明了垂直花园。2010年，去香港绿色链接库斯特学习绿墙制作，办公室外墙那幅郁郁葱葱、生机勃勃的绿墙深深吸引了我，同年年底我转往香港工作，从此开始和绿墙结下了缘分。

1 Green wall in Hong Kong Greenlink Küsters office

2 Museum of Quai Branly, Paris, photo taken in December 2012

1 香港绿色链接库斯特室外绿墙

2 巴黎Quai Branly博物馆绿墙，2012年12月拍摄



Hotel Pershing Hall (2001, outdoor and indoor), Museum of Quai Branly (2005, outdoor), Espace Club Med (2007, indoor), BHV home Boutique (2007, outdoor), Rue d'Alsace (2008, outdoor), Museum National d'Histoire Naturelle (2010, indoor); Plus Lan Restaurant (2008, indoor) in Shanghai, and Hotel Icon (2011, indoor) in Hong Kong, all together 10 green walls, by Patrick Blanc. They are generally quite successful; the oldest one is still lush after 19 years. But the green wall at Rue d'Alsace, some part of the green wall is dead, lack of necessary care and maintenance. It teaches us: the maintenance plan needs to be organised before installation, very important!



The devil is in the details, cliché but true! Plant species, the pattern, irrigation and drainage, illumination for indoor green wall, growth medium, fertilizer, regular maintenance and supervised irrigation, all these details could make a successful green wall.

The urbanization has taken forests and vegetated areas, and the price of land is growing up sharply; thus a garden on the ground is more and more unaffordable. Fortunately we could build green roofs and green walls which are new approaches to invite nature back to the city. The green roofs have successful stories, but green walls need more and in-depth research.

If you find some information useful from this book, I would be more than happy. Obviously there is no single instruction that could be applied to every situation, and thus you have to check the site before adapting the data from this book. Should you have any question or suggestion or whatever, please write to me: [greenwall\\_jialin@hotmail.com](mailto:greenwall_jialin@hotmail.com).

A new venture would be successful only if all the stakeholders invest in it. We are having 'better city, better life', and vertical greenery is one of the most awarding investments.

到目前为止，我已经完成的绿墙大大小小加起来超过2500平方米了，有成功的项目，也有失败的项目，走了许多弯路，交了许多学费，通过实践基本掌握了绿墙的技术，可是还有很多问题没有答案。2012年年底，我特地去巴黎实地考察帕特里克·布朗克的绿墙，包括巴黎植物园（1994年建，室外绿墙），卡地亚基金会总部（1998年建，室外绿墙），Pershing Hall 酒店（2001年建，室外绿墙和室内绿墙），Quai Branly 博物馆（2005年建，室外绿墙），Espace Club Med 旅行社（2007年建，室内绿墙），BHV homme 精品店（2007年建，室外绿墙），Rue d'Alsace 法国铁路公司公寓（2008年建，室外绿墙），法国自然博物馆（2010年建，室内绿墙）；加上帕特里克·布朗克在上海设计的兰餐厅（2008建，室内绿墙），在香港设计的唯港荟（2011年建，室内绿墙），总共10个。这10个绿墙总体来看是成功的，最早建成的绿墙已经近20年了，还长得郁郁葱葱。不过也有不足的地方，尤其是Rue d'Alsace 法国铁路公司公寓这幅绿墙，因为缺乏必要的维护，很多植物已经枯萎。这也提醒我们：组织好绿墙的后期维护是多么重要！

总结起来，还是那句老话：细节决定成败。植物品种的挑选和图案组合，灌溉和排水的设计，补光照明(室内绿墙)的设计，种植土的配比，营养液的添加，加上定时定期的检查保养，这几个要素设计周全了，一幅生机勃勃的绿墙就指日可待了。

随着城市化水平提高，市区的地价屡创新高，地上的花园显得越来越奢侈，屋顶绿化和墙体绿化开辟了一种让大家接近自然的新途径，屋顶绿化技术已经很成熟，墙体绿化的研究还不够深入。

这本书如果对你有所助益的话，我颇感欣慰。如果你有任何意见和建议，你可以写电子邮件给我，[green-wall\\_jialin@hotmail.com](mailto:green-wall_jialin@hotmail.com)。

一项新的事业需要所有参与者的共同付出才能健康发展，愿鸟语花香回归都市，愿我们的城市越来越宜居，“城市让生活更精彩”！



## 1. Summary

### 1.1 Urbanization and vegitecture

It is an urban world! More than 50% of humanity now lives in the city, and 70% will be city dwellers by 2050, according to an UN report! Fig.1.1

This increasing force of urbanization results in 'concrete forest' taking place of the natural vegetation and forested area. This change has led to an increase in urban temperature, which in turn brings about an increase in energy consumption in buildings.

Imagine a city we can enjoy freedom, democracy, efficiency, and even more, completely green? Ecological and sustainable, green as far as the eye can see? Fig.1.2

This fantasy is becoming a reality around the world. The movement known as vegitecture, or vegetated architecture, is taking off, and is not just beautiful, but is also an environmentally friendly way to literally add a piece of nature to the city.



## 1. 垂直绿化概述

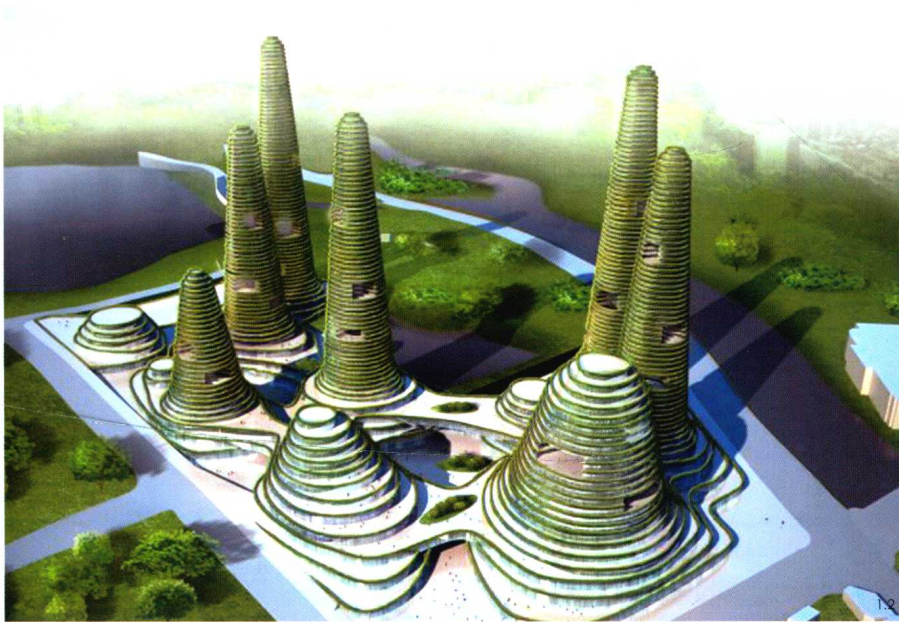
### 1.1 城市化和植物建筑 ( vegitecture )

这是一个城市化的世界！一份联合国报告表明：当今世界，已经有超过50%的人类生活在城市中，而到2050年，这一数据将会升至70%。如图1.1

不断加速的城市化进程夺走了大量的绿色植被和森林，取而代之的一片片由高楼大厦汇成的“水泥丛林”。这样的改变不仅使城市变暖，更增加了能源的耗损。

您是否也曾做过这样的想象：有一天，我们将生活在一座自由、民主而高效的绿色城市中。这座城市生态环保、可持续，眼睛所能触及的地方皆是绿色。如图1.2

如今，一种在全球范围内悄然兴起的新型建筑方式正逐渐将这一想象转变成现实。这种建筑方式被称为植物建筑 ( vegitecture )，或是植草建筑 ( vegetated architecture )，不仅外表美观，更能以节能环保的方式为城市增加绿意。



## 1.2 Vegitecture and skyrise greenery

The vegitecture is using the vegetation as the prime component of the building, we can name this kind of greenery 'skyrise greenery', which means green space at the building beyond the ground level, including green roof, green wall, sky gardens, terrace planting, etc.

There are two approaches to implement the 'skyrise greenery': green roof and green wall. The green roof is the planting work mainly focused on the horizontal dimension, while the green wall on the vertical dimension.

Green Roof is now quite successful and widely accepted worldwide. In this book, we will focus on the green wall.

In the last twenty years, it is Patrick Blanc's innovative green wall that hoards the world's attention for the lush, bountiful displays of plants. Many have seen the potential of the industry, and are investing in it. More and more green walls have been used, for advertising, cosmetics, and urban

### 1.2 植物建筑和空中绿化 (skyrise greenery)

植物建筑以绿色植物为主体材料，其绿色空间位于地面以上，是一种空中绿化，包括绿色屋顶、垂直绿化、空中花园和露台绿化带等。

空中绿化的方式主要有两种：绿色屋顶和垂直绿化。前者主要是在水平方向上种植绿色植物，后者则是指垂直方向上的。

现如今，绿色屋顶已经取得了巨大成功，在世界范围内得到广泛认可。因此，在本书中，我们将着重介绍垂直绿化。

在过去的二十年中，帕里克·布朗克博士所创造的苍翠繁茂的垂直绿化吸引了全世界的目光。许多人看到这个新兴产业的发展潜力，对其进行投资，因此，垂直绿化逐渐被应用在广告业、化妆品业以及城市农业等众多领域中。此外，一些大型盛会也开始把垂直绿化作为重要的组成部分，其中一个例子是2010年的

1.1. Dense Urban Area in Hong Kong

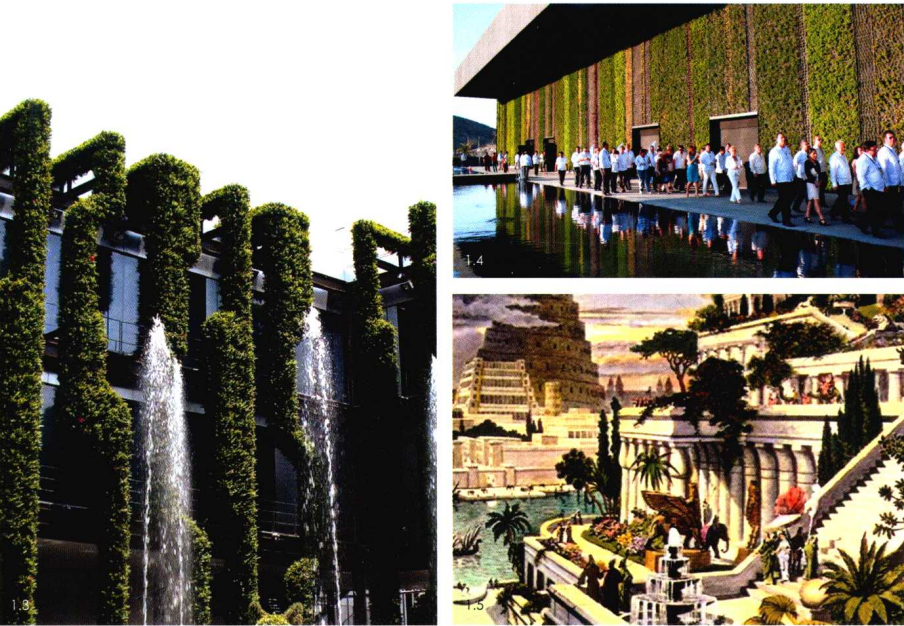
1.2. Vegitecture Design by Dutch architects MVRDV

1.1. 香港密集的城市空间

1.2. 由荷兰建筑设计事务所MVRDV所设计的植物建筑



agriculture, etc. Some big events are using green walls as a strong feature. One example is the Shanghai EXPO 2010, the green walls could be found in French Pavilion, Canadian Pavilion, India Pavilion, Swiss Pavilion... with different designs and structures, illustrating the theme of Better City, Better Life' (Fig.1.3). A more recent example is the green wall at the convention centre of the G20 summit held in Mexico in 2012. Fig.1.4



1.3 A brief history of green walls

The concept of the green wall dates back to 600 BC with the Hanging Gardens of Babylon, one of the seven ancient wonders of the world, and the only one of the Wonders that may have been purely legendary. Ancient writers describe the possible use of something similar to an Archimedes screw as a process of irrigating the terraced gardens. Estimates based on descriptions of the gardens in ancient sources say the Hanging Gardens would have required a minimum amount of 8,200 gallons (37,000 litres) of water per day. Nebuchadnezzar II is reported to have used massive slabs of stone, a technique not otherwise attested in Babylon, to prevent the water from eroding the ground. Fig. 1.5

上海世博会，在法国馆、加拿大馆、印度馆、瑞士馆等众多展馆中，都可以看到不同设计、不同结构的垂直绿化，完美诠释了“城市，让生活更美好”这一主题（如图1.3）。一个更为近期的例子是2012年在墨西哥举行的G20国峰会，其会议中心也同样出现了垂直绿化的身影，如图1.4。

1.3 垂直绿化简史

垂直绿化的概念最早可以追溯到古巴比伦王国的“空中花园”（Hanging Gardens of Babylon），“空中花园”是世界古文明的七大奇迹之一，也是其中传奇色彩最为浓厚的一个。在古代作家的笔下，古巴比伦人是用一种类似于阿基米德螺旋抽水机的机器来对“空中花园”进行灌溉的。而在对古籍中有关空中花园的描述进行系统研究后，现代人发现：“空中花园”每天最少需要8200加仑（约合37000升）的灌溉水。据介绍，在尼布甲尼撒二世时期，古巴比伦人还曾使用大型的厚石板防止水对地面的侵蚀，虽然这一技术尚未被证实是否真正起源于古巴比伦（如图1.5）。

1.3 French Pavilion in EXPO Shanghai 2010  
1.4 G20 Summit Convention Centre, Mexico  
1.5 A 16th-century hand-coloured engraving of the 'Hanging Gardens of Babylon' by Dutch artist Martin Heemskerck, with the Tower of Babel in the background.  
1.3 2010年上海世博会法国馆  
1.4 2012年墨西哥G20国峰会会议中心  
1.5 一幅由16世纪荷兰艺术家马丁·赫姆斯科克创作的关于古巴比伦“空中花园”的手工雕刻艺术品，作品中，“空中花园”以巴别塔作为背景

Highlights of the history of green walls are provided below:

**300 BC to 17th C. AD:** Throughout the Mediterranean, Romans train grape vines (*Vitis* species) on garden trellises and on villa walls. Manors and castles with climbing roses are symbols of secret gardens.

**1920s:** The British and North American garden city movement promoted the integration of house and garden through features such as pergolas, trellis structures and self-clinging climbing plants.

**1988:** Introduction of a stainless steel cable system for green facades.

**Early 1990s:** Cable and wire-rope net systems and modular trellis panel systems enter the North American marketplace.

**1993:** First major application of a trellis panel system at Universal CityWalk in California.

**1994:** Indoor living wall with bio-filtration system installed in Canada Life Building in Toronto, Canada.

**In the 1990s and 2010s:** It is Patrick Blanc's innovative hydroponic green wall that hoards the world's attention for his lush, bountiful displays (Fig. 1.6). Many have seen the potential of the industry, and more and more green wall systems have been examined and used, for advertising, cosmetics, and urban agriculture, etc.

**2002:** The MFO Park, a multi-tiered 300' long and 50' high park structure opened in Zurich, Switzerland. The project featured over 1,300 climbing plants.

**2005:** The Japanese federal government sponsored a massive Bio Lung exhibit, the centerpiece of Expo 2005 in Aichi, Japan. The wall is comprised of 30 different modular green wall systems available in Japan.

垂直绿化历史要点的回顾如下:

公元前3世纪至公元17世纪: 生活在地中海沿岸的罗马人把葡萄藤类植物栽种在花园的棚架以及别墅的外墙附近, 爬满藤蔓月季的庄园和城堡成为这一时期秘密花园的重要象征。

19世纪20年代: 兴起于英国和美国的花园城市运动提倡住宅与花园的融合, 其中就包括充分利用藤架、格子结构以及自行攀爬植物等元素。

1988年: 引入不锈钢线缆式垂直绿化系统。

19世纪初: 线缆式系统、网架式系统以及格板式模块系统开始进入美国市场。

1993年: 位于加利福尼亚州的环球影视垂直绿化正式落成, 该垂直绿化采用格板式模块系统, 是人类历史上首次应用如此大规模的垂直绿化。

1994年: 坐落于加拿大多伦多的加拿大生活大厦, 其内部安装了一面带生物净化系统的室内活体绿墙。  
19世纪与20世纪之间: 帕特里克·布朗克极富创造性的水培系统垂直绿化, 凭借其繁茂而丰富的植物配置吸引了世界的目光(如图1.6)。许多人看到垂直绿化行业的巨大发展潜力, 开始对其进行研究, 因此, 新的垂直绿化系统层出不穷, 垂直绿化还被应用在广告、化妆品以及城市农业等诸领域中。

2002年: MFO公园垂直绿化正式落成, 这座长7.62米、高1.27米的多层式垂直绿化位于瑞士北部城市苏



**2006:** After changing the building codes, Paris became the centre of new plants, and 39 different vertical gardens emerged around the city. Special irrigation system is an essential part of vertical gardens, for this reason, the supporting structure must cling to walls as closely as the wall cladding. There should be at least 30 plants per sqm so the green wall can look lush and flourishing.



1.4 Benefits of living walls

Environmental

Living walls help to reduce local wind speeds, traffic noise, and localized temperature extremes (urban heat islands) by shading and converting liquid water to water vapour (evapotranspiration) which cools the air. They help to improve air quality by reducing dust and particulates and help to reduce the amount of heat lost from a home. Another significant benefit is the increase in biodiversity, along with aid for food and shelter for wildlife. Living walls can also significantly increase infiltration and storage of rainwater through their root systems.

Social

Living walls may have a positive impact on both physical and mental

well-being, and contribute to a sense of community and social cohesion.

2005年：日本联邦政府赞助打造了一个大型的“生命绿肺”，作为2005年爱知（日本的一个县）世博会的中心展品，该垂直绿化涵盖当时日本存在的所有类型的模块系统（共30种）。

2006年：巴黎改变建筑条例，成为新植物品种的中心，出现了39个垂直花园。垂直花园需要特殊的灌溉系统，这要求承重结构必须像表面覆盖层一样贴在建筑的墙上。要形成浓密的绿墙，每平方米覆盖的植株多达30株。

于2010年竣工的长木花园垂直绿化面积为4072平方英尺，是匹兹堡国民银行垂直绿化（当时北美洲面积最大的垂直绿化）的1.7倍，成为新的北美第一。

1.4 垂直绿化的效益

环保效益

垂直绿化不仅可以遮阴，还能通过液态水转变成水蒸气（即蒸腾作用）的方式使空气变凉，起到降低局部地区的风速、减少交通噪音以及缓解极端温度（城市热岛效应）的作用。垂直绿化可以减少空气中的灰尘和微粒物质，提高空气质量，维持室内温度的平衡。它的另一个显著优势在于：能够增加生物的多样性，为野生动植物提供食物和避难所。此外，垂直绿化还能通过其发达的根系增强雨水的渗透作用和增加蓄水量。

1.6. Parc Floral de Paris (1994), Patrick Blanc

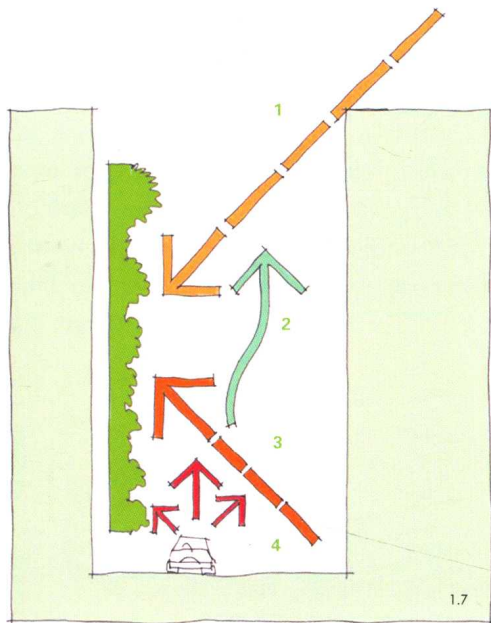
1.6 巴黎植物公园（1994年），由帕特里克·布朗克设计

health and wellbeing. Green views and access to green spaces in cities help and relieve the everyday pressures of crowding and noise. They may have a positive impact on crime reduction since residents living in ‘greener’ surroundings actually report lower levels of fear, fewer incivilities, and less violent behaviour. Living walls can benefit communities socially by instilling higher public esteem and pride for an area.

Economic

Living walls and other planting have the potential to increase residential and commercial property values by 7% to 15%. They help to create a positive perception for prospective purchasers of property. They soften newly built houses and give immediate character and warmth. Further, they can improve the environmental performance of buildings and therefore the economic performance through reducing heating and cooling costs.

Living walls provide screening and /or barriers where fencing regulations may limit alternatives. They may enhance the prospects of securing planning permission. Fig.1.7



1.7. Urban canyon with living wall  
1. Short wave radiation  
2. Evapotranspiration  
3. Long-wave infrared radiation  
4. Anthropogenic heat

社会效益

垂直绿化对人类的身心健康和幸福安康都能产生积极的影响。垂直绿化可以提供绿色的视野，让久居喧嚣城市的人们有机会接近绿色，起到缓解日常压力的作用。垂直绿化甚至有可能降低犯罪率，据报道：生活在更为“绿色”环境中的人们产生恐惧心理、从事不文明以及暴力行为的频率均低于平均水平。与此同时，垂直绿化还能通过提高地区声誉、增加居民“社区自尊心”的方式，造福于社会。

经济效益

垂直绿化和植物带，能够将住宅和商业地产的价值提升7%到15%，有助于增强潜在购买者的购买信心。垂直绿墙和植物带的存在，不仅可以让新建筑更加柔软温馨、个性十足，还能降低供冷供热成本，提高经济效益。

垂直绿化可以为建筑增加屏障，提高建筑的安全性。如图1.7。

1.7 “城市峡谷”与垂直绿化  
1. 短波辐射  
2. 蒸腾作用  
3. 长波红外线辐射  
4. 人为排热



## Energy Saving

Naturally everything heats up when exposed to solar radiation. A building is no different. During the summer it leads to an increased demand on cooling systems and the energy they require. Studies have shown that the surface of an exterior green wall is up to 10°C cooler than an exposed wall, therefore considerably less heat is radiated inward. Not only do green walls reduce cooling requirements but they also help to mitigate the urban heat island effect. The Sustainability and LEED® Credits sections go into greater detail about this effect and how green walls or living walls help.

Interior green walls also help to save energy during the summer. Through the process known as transpiration plants actually cool their surrounding environment slightly. With each additional plant this increases and therefore a green wall, with hundreds of plants, can reduce the temperature of a room by anywhere from 3 to 7°C. Some studies have shown that interior green walls can cut electricity bills by up to 20%!



## 节能效益

很显然,曝露在太阳辐射下的任何物质都会急速升温,建筑也不例外。到了夏季,因为表面受热,建筑对于制冷系统和能量的需求也会迅速提升。研究表明,安装了垂直绿化的建筑,其表面温度要比没有安装垂直绿化的建筑表面温度低 10 摄氏度,室内温度较为凉爽。垂直绿化不仅可以减少制冷所造成的能量消耗,还有助于缓解城市的热岛效应。美国民间绿色建筑认证奖项 LEED 对城市热岛效应做了较为详细的研究,并且详细阐述了垂直绿化和活体绿墙是如何缓解这一效应的。

室内垂直绿化同样可以在夏季起到减少能量耗损的作用。经过蒸腾作用,植物可以使周围温度有所降低。虽然每一株植物为“降温”所能做到的“贡献”很小,但是当成百上千株植物集中在一面垂直绿墙上时,室内温度就可以降低3到7摄氏度。一些研究表明,安装室内垂直绿化可以将每个月的用电账单减少近20%!

1.8 Green Wall failed at Paradise Park in London, UK.

1.8 英国伦敦天堂公园的垂直绿化以失败告终

## 1.5 Green wall and its future

While green walls are catching the attention and the heart of the public, sometimes they failed. The most famous of these was the death of the green wall at Paradise Park in London, UK. The wall at the Islington Children's Centre, installed in 2006, was the first large-scale green wall in the UK, and received a great deal of publicity. However, after a short three years the wall was dead. A combination of factors, including the choice of plants, the irrigation system, the growing medium, as well as not enough attention paid to the maintenance were blamed for the death. Fig.1.8

The failure is very expensive; it has led to questions about the viability and sustainability. However, this failure will make people more aware of the critical issues that need to ensure being incorporated into the design of a green wall. Jeremy Blake, principal at Purcell Miller Tritton, installed a nine-storey green wall at the refurbished Athenaeum Hotel in London, he said: 'You're dealing with a living organism and that means it needs to be appropriately selected, appropriately installed and well maintained and irrigated. The three key elements for a successful living wall are the growing medium, monitored irrigation, and appropriate plant types for that kind of exposure' (Merlin Fulcher, architects journal, 18 September, 2009).

Yet we have some beautiful and successful green wall, both interior and exterior. Using the right plants in the right place as well as understanding the science behind the technology is key to a green wall's longevity. The growth, the stability and the long term viability of the green wall will be achieved through the well-rounded research, design, training, installation, and maintenance programme.

## 1.5 垂直绿化及其未来

在吸引大众越来越多关注的同时，垂直绿化也难免遭遇失败，其中最为典型的案例当属位于英国伦敦的天堂公园（Paradise Park）垂直绿化项目。这一项目位于伊斯灵顿儿童中心（Islington Children's Centre），于2006年安装，是英国最大的垂直绿化项目，因此备受公众瞩目，然而，仅仅过了三年，项目就以失败告终。致使其失败的因素很多，其中包括植物选择不当、错误的灌溉系统、不恰当的生长介质（growing medium）以及维护的匮乏等。如图1.8。

天堂公园垂直绿化的失败所付出的代价是高昂的，它引发了人们对于垂直绿化的可行性和可持续性的质疑。然而，失败也给人们以警示，让人们意识到垂直绿化设计所要考虑的关键因素。在为伦敦雅典娜神庙酒店翻新项目安装了一面9层高的垂直绿化后，珀塞尔·米勒特里顿事务所的负责人杰里米·布莱克说道：“在设计一个垂直绿化项目时，你所面对的是一个生命有机体，这就意味着，植物的选择、垂直绿化的安装与维护，以及灌溉系统都必须十分妥当。垂直绿化的成功主要取决于三点：生长介质、监控式灌溉系统和植物类型。”（梅林·福尔切尔，《建筑师期刊》，2009年9月18日）

无论如何，我们还是拥有不少美丽而成功的室内室外垂直绿化项目。如果想让一个垂直绿化项目持久，那么人们必须在恰当的地方栽植恰当的植物，并且理解垂直绿化技术背后所蕴含的科学。只要做到研究和培训足够充分、设计全面、安装科学、维护合理，那么，垂直绿化就会取得成功，并能持续很久。



2. Green Wall Systems

2.1 Definition

Green Wall can be simply defined as a wall covered with plants. Or more detailed, according to Wikipedia, a green wall is a wall, either free-standing or part of a building, which is partially or completely covered with vegetation and, in some cases, soil or an inorganic growing medium.

From the vegetation perspective, we can classify the green wall into two categories: natural green wall and artificial green wall. Fig.2.1-2.2

Natural green wall (green façade), uses climbers, creepers, or vines, sometimes with the help of supporting structure, to cover the wall. The plants root in ground soil, in planter or in container. They absorb water and minerals from the soil. Additional irrigation is not essential, but desirable. The natural green wall is mostly outdoor green wall.

Artificial Green Wall with the names of Vertical Garden (Mur Végétale), Living Wall, Planting Wall, is using non-climbing plants. The plants root in felt or in growth medium housed in modular. The plants get water and minerals from the felt or from the growth medium. Irrigation system is essential, usually with automatic control. The artificial green wall could be implemented both indoor and outdoor.

Their comparison could be summarized as follows:

	Natural Green Wall (green façade) 自然垂直绿化 (绿色外墙)	Artificial Green Wall (vertical garden, living wall) 人工垂直绿(垂直花园、活体绿墙)
Climbing Plants 是否采用攀爬类植物	Yes 是	No 否
Rooting 生根位置	Ground soil, planter, or container 地面、植物槽或其他容器内的土壤中	Felt or growth medium 植物毡或生长介质中
Irrigation 灌溉系统的重要性	Not essential 不重要	Essential 重要
Indoor / Outdoor 适用于室内还是室外	Outdoor mostly 大多位于室外	Both 两者皆可

2. 垂直绿化系统

2.1 定义

垂直绿化可以简单定义为表面覆盖着植物的墙体。维基百科给出的定义则较为详细：垂直绿化是指墙体的部分表面或者全部表面被绿色植物所覆盖。这里所指的墙体既可以是单独的一面墙，也可以是作为建筑的一部分而存在的墙体。在某些情况下，垂直绿化需要土壤或无机生长介质。

从植物的角度出发，垂直绿化可以分成两类：自然垂直绿化（Natural Green Wall）和人工垂直绿化（Artificial Green Wall）。如图2.1、图2.2。

自然垂直绿化（也称绿色外墙green façade）主要利用攀爬类和藤类植物来覆盖墙体，在某些情况下，将需要必要的支撑结构作为辅助。自然垂直绿化的植物扎根于地面、植物槽或是其他容器内的土壤中，从土壤中吸收水分和矿物质。自然垂直绿化通常位于室外。

人工垂直绿化又名垂直花园（Vertical Garden）、活体绿墙（Living Wall）以及植物绿墙（Planting Wall），主要采用非攀爬类植物。人工垂直绿化的植物扎根在置于模块中的植物毡或生长介质中，从植物毡或生长介质中吸收水分和矿物质。灌溉系统是人工垂直绿化不可或缺的一部分，通常是自控式的。人工垂直绿化既适用于室内，也适用于室外。

左边表格简单归纳了自然垂直绿化和人工垂直绿化两者之间的区别。