索尼大崎大厦生物外皮
——为城市降温的高保水瓷砖的外部系统

Bio Skin of Sony's Osaki New Building Project: Development of an Exterior System that Uses High Water-retentive Ceramics for Purposes of Urban Cooling

业主 索尼公司
地点 日本东京
建筑设计 Nikken Sekkei Ltd.
合作设计 索尼设施管理公司联合设计
建筑设计团队 Tomohiko Yamanashi，Tatusya Hatori，Yoshito Ishihara，Norihisa Kawashima
资料提供 Nikken Sekkei Ltd.

摄影师：野田东德

占地面积：16 558.52m^2
建筑面积：10 611.26m^2
总楼面面积：124 041.48m^2
结构：S/SRC/RC
楼层：地上 25 层，地下2层
高度：139.35m
停车场容量：253 辆
工期：2009年 2 月~2011年 3 月

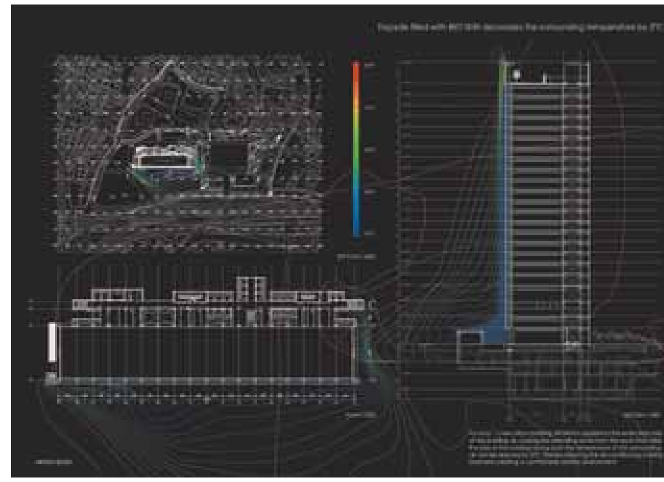
1 建筑概况与生物外皮

2011 年3 月，位于大崎站（东京品川市）西门的索尼公司新的研发大楼竣工。这座大楼采用了被称作“生物外皮”的创新外部系统，是由日建设计研究院和几家合作伙伴最新开发的成果。“生物外皮”可以减少楼内的热负荷，有助于降低城市热岛效应。具体来说，“生物外皮”一方面发挥着东北面阳台栏杆的功能，另一方面在早上又成为遮阳罩。此外，由于其在蒸发冷却方面具有的功效，可帮助降低周围地区的温度，从而有助于缓解热岛效应。而“生物外皮”的精美外表还有助于防止人们因该大楼的庞大而感到压抑。

该大楼的设计非常紧凑，创造出一个被灌木丛和树木所包围的景观场所。此外，大楼的设计使得夏季从南面东京湾刮来的凉风所受到的阻碍较少，以便进入内陆区域，促使“生物外皮”和小树林带走部分热量。这是为充分利用场地条件而做出的努力。该场地位于目黑河和东京湾附近的流域内，事实上是日本史前“绳纹时代”的海洋底部。

2 开发背景

索尼公司已经拥有一座高性能的绿色大楼作为其总部，因此在规划新的研发办公楼时要求大楼在建筑环境的层面作出新的尝试。为了回应这一要求，Nikken Sekkei建议以减少热岛效应作为基本环境主题，并获得索尼公司的认同和批准。这一建议的背景是基于东京一直在经历的严重的热岛现象而提出的，近年来该现象还偶尔引发出乎意料的大雨，被人们称之为“游击雨” 。

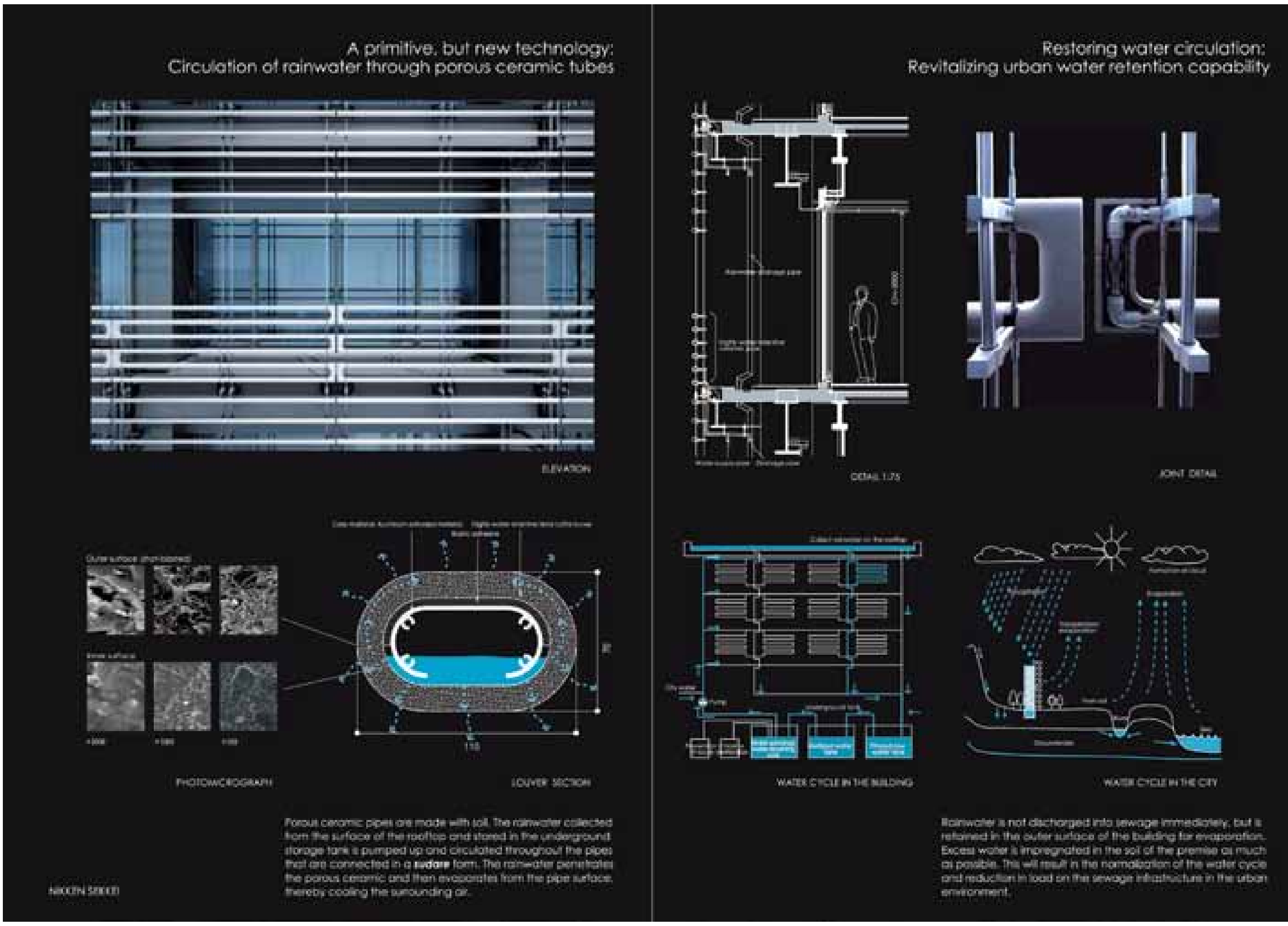


平面及剖面图

1. Architectural overview and BIO SKIN

In March 2011, construction of Sony’s new R&D office building was completed near the West Gate of Osaki Station (Shinagawa City, Tokyo). In this building, an innovative exterior system called the BIO SKIN, newly developed by Nikken Sekkei with several partners, has been adopted. The BIO SKIN enables reduction of the heat load inside the building and helps reduce the urban heat island effect. Specifically, the BIO SKIN functions as a handrail of the balcony on the northeast façade of the building and as a sunshade during the morning hours. Moreover, thanks to its efficacy in evaporative cooling, the BIO SKIN helps reduce the temperature in the surrounding areas and thus contributes to mitigate

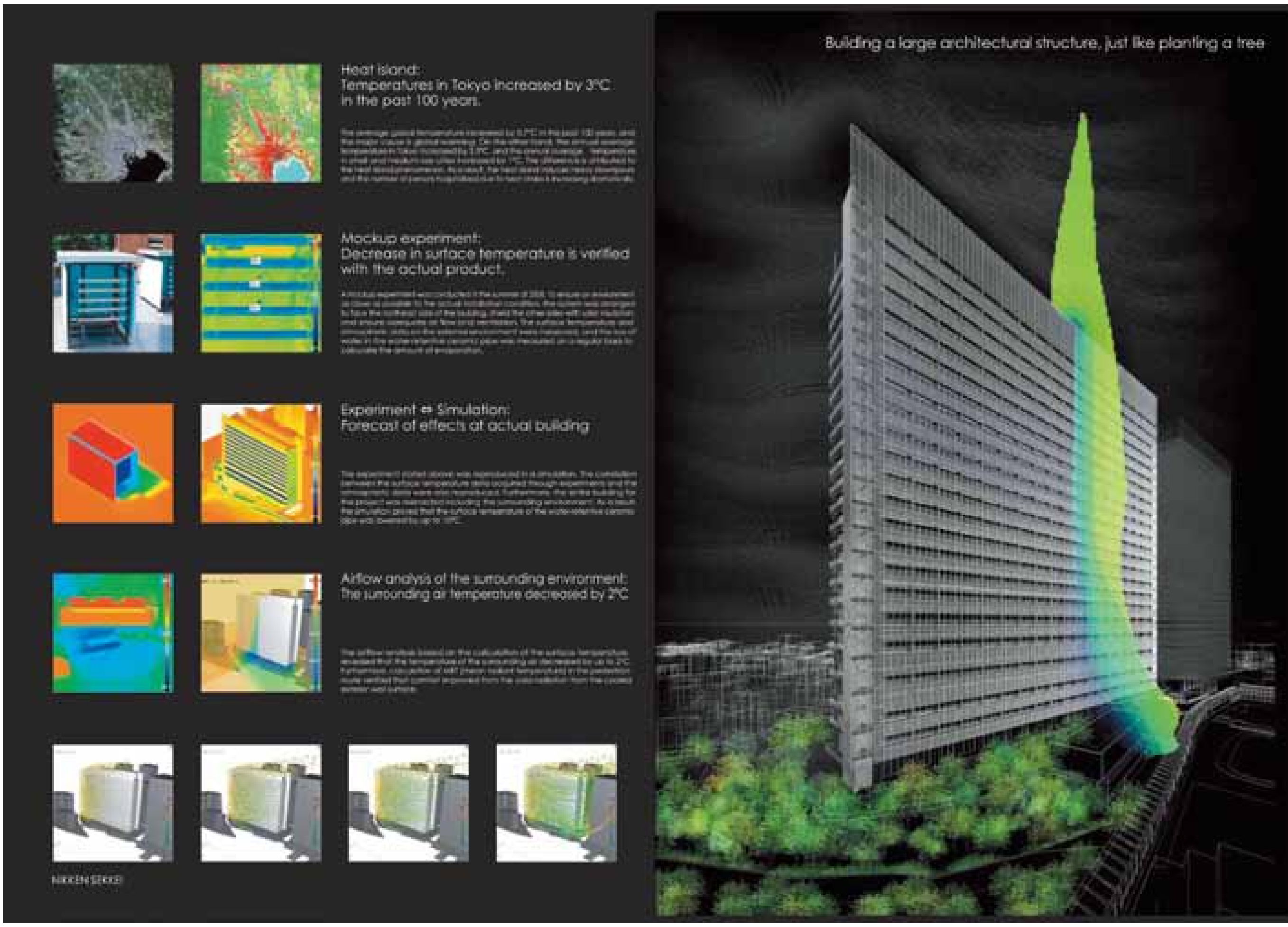
摄影师：野田东德


A primitive, but new technology:
Circulation of rainwater through porous ceramic tubes
ELEVATION
PHOTOMICROGRAPH
LOUVER SECTION
Porous ceramic pipes are made with soil. The rainwater collected from the surface of the rooftop and stored in the underground storage tank is pumped up and circulated throughout the pipes that are connected in a **sudare** form. The rainwater penetrates the porous ceramic and then evaporates from the pipe surface, thereby cooling the surrounding air.
NIKKEN SEKKEI
Restoring water circulation:
Revitalizing urban water retention capability
DETAIL 1:75
JOINT DETAIL
WATER CYCLE IN THE BUILDING
WATER CYCLE IN THE CITY
Rainwater is not discharged into sewage immediately, but is retained in the outer surface of the building for evaporation. Excess water is impregnated in the soil of the premise as much as possible. This will result in the normalization of the water cycle and reduction in load on the sewage infrastructure in the urban environment.

表皮细部构造


摄影师：野田东德


摄影师：铃木丰



生物表皮功效分析

Nikken Sekkei Research Institute（简称“NSRI” ）和其他工作人员利用热环境模拟研究了各种设计的可能。虽然植被数量的增加被证明可有效减少热岛效应，但是由于其所在位置，新楼的主立面要面对东北方，因而就不适宜采用植被覆盖的墙体。此外，即使在大楼的周围增加绿化，其空间也十分有限。而后，规划小组发现如果大楼本身能够像树木那样减少热岛效应，就会取得显著的效果。而日本夏季的传统冷却方法，即在房子周围洒水降温，也给设计师带来了灵感。所有这些努力的结果是创建了一个系统——用大楼外表面上的内部多孔陶瓷管使雨水得到蒸发。

3 开发过程——从微观问题到城市规模问题

在应对所选定的基本设计原则提出的挑战时，我们需要从早期开始就与制造商和研究机构进行合作。我们的研究范围广泛，包含从微观层面到城市规模层面的多层面问题。

（1）“生物外皮”可使温度降低多少?

我们所做的第一项工作就是对“生物外皮”材料进行模拟试验。具体来说，就是使用适合内部水分蒸发并易冷却的多孔赤陶土，把赤陶土制成的样品百叶窗和铝制的普通样品百叶窗都安装起来，朝向与实际的建筑平面图相同的方位，然后定期记录其表面温度、环境温度、蒸发量、周围区域温度和湿度以及风速等数据。经过测试发现，潮湿的赤陶土百叶窗的温度比铝制百叶窗要低5°C~6°C，由此证明赤陶土具有优良的冷却功能。此外，试验还为表面温度与蒸发量与外部环境的相关性提供了证据。

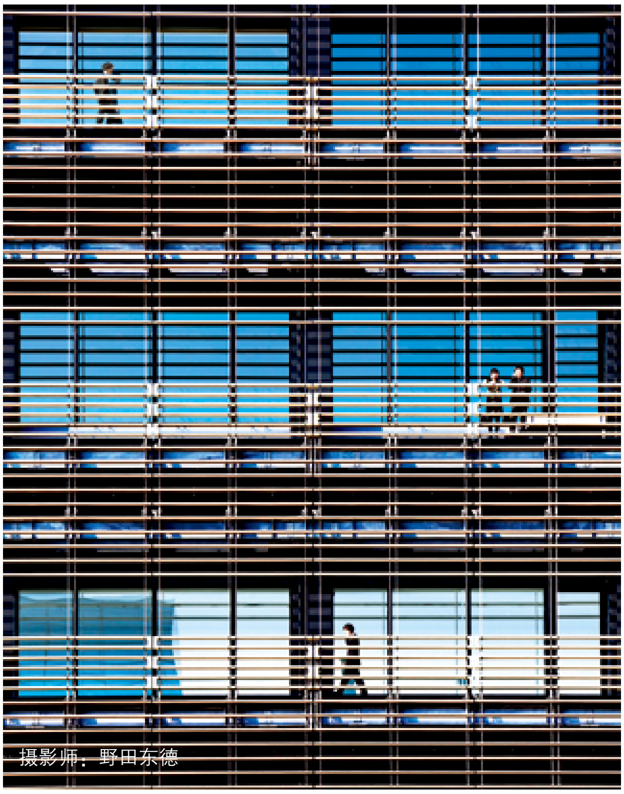
the heat island effect. The BIO SKIN’s delicate appearance also helps people feel less overwhelmed with the largeness of the building.

The building was designed to be compact, enabling to create an area landscaped with bushes and trees. In addition, we have designed the building to have a smaller area facing the prevailing wind from the south, so that in the summer, the cool wind from the Tokyo Bay is blocked less and is allowed to blow to inland areas with some heat being taken away with the BIO SKIN and the grove. These are the efforts to make best use of the site, which is located in a valley near the Meguro River and the Tokyo Bay, and in fact, was the bottom of the ocean in the Japanese prehistoric “Jomon Era.”

2. Development background

In planning the new R&D office building, Sony, the client who had already owned a high-performance green building as its head office, requested that the R&D building make further progress in corporate environmental performance. Nikken Sekkei responded to the request by proposing to make the mitigation of the heat island effect the underlying environmental theme, and this was approved by Sony. As background to our proposal, it is worth noting that Tokyo has been experiencing a serious urban heat island phenomenon, which also triggered occasional unexpected heavy rain called "guerrilla rain" in recent years.

The Nikken Sekkei Research Institute （NSRI）, our landscape designers, and other staff studied various options by using heat environment simulation. While an increase in the amount of vegetation is proven effective in reducing the heat island effect, the site of the new building is



（2）“生物外皮”用于楼宇的效果

试验结果证实了用赤陶土制成的百叶窗具有空气冷却效果，故决定将其用于大楼的外墙，这也就是我们所说的“生物外皮”。根据测量数据进行的大量模拟表明，“生物外皮”的表面温度在夏季最炎热的日子里可降低 10ºC，而气流分析则表明“生物外皮”墙面有助于把周围走道和门厅的温度降低 2ºC。配有“生物外皮”的外墙玻璃表面附近的温度每一层楼也要低 1ºC~2ºC，由此在夏季可以减少对空调的使用。热岛效应已经把东京的年平均气温提高了 3ºC，相对于其他城市高了 2ºC 。我们的结论是将周围的温度降低 2ºC 应当是一个可行的目标。

（3）霉菌、苔藓、冰塞和堵塞问题

赤陶土因吸水率高，往往会长出霉菌和苔藓。对这一问题的解决办法是在赤陶土百叶窗上采用光触媒（氧化钛TiO_2）涂层，并且将百叶窗安装在通风良好的地方，留出充足的间隔空间。吸水率高的性能还可能在冬天造成冰塞。解决办法是使百叶窗成为带有一定厚度的对称形状，这有助于分散因水结冰而产生的扩张和收缩应力。此外，挤压成型法会增加材料表面的密度从而导致堵塞的发生。为防止这一现象，在制作过程中增加了将表层外皮的一部分进行刮去的内容。

（4）系统和设备（供水、排水、传感器）

“生物外皮”将雨水在楼顶进行收集，储存在地下室内的储水箱中，过滤后采用加压泵提供给每层楼的外皮系统。如果因连续晴天造成雨水缺乏，也可采用纯净水。我们还安装了测量传感器，并设立了系统，使得楼宇能源管理系统（BEMS）能够对冷却效果进行监控。

（5）张力结构支撑系统

采用张力结构的目的是使“生物外皮”只需最少的部件来支

such that the main facade would face northeast, making it unfavorable for use of a wall covered with vegetation. In addition, there was limited space to add plantings around the building. The planning team then found out that a significant effect could be delivered if the building itself could have a similar heat island mitigating effect as trees provide. They were also inspired by the Japanese traditional cooling method of sprinkling water around the house in the summer. These efforts have resulted in creating a system to evaporate the rainwater from inside porous ceramic tubes on the exterior surface of the building.

3. Development process - Studied from microscopic issues to urban-scale issues

In overcoming the challenge presented by the basic design principle thus chosen, we needed to collaborate with manufacturers and research institutions from an early stage. We studied a wide range of issues from the microscopic level to the urban-scale level.

(1) How much can the BIO SKIN cool down?

The first work undertaken was mock-up experiments of BIO SKIN materials. Specifically, we used porous terra cotta that is suitable for evaporation of internal moisture. The sample louver made of terra cotta which has high evaporative cooling capacity and an ordinary sample louver made of aluminum were installed to face the same direction as the actual building plan and their surface temperature, ambient temperature, amount of evaporation, temperature and humidity of the surrounding areas, and wind speed were measured at periodic intervals. We found that the temperature of the wet terra cotta louver was 5-6ºC lower than that of the aluminum louver, proving the superior cooling capacity of terra cotta. In addition, the experiment provided evidence of correlation of the surface temperature and evaporation amount with the external environment.

(2) BIO SKIN’s effects when used on a building?

The result of the experiment confirmed the air cooling effect of the louver made of wet terra cotta. We named it the “BIO SKIN” and decided to use it for exterior walls of the building. The numerical simulation, based on

持。在适当考虑了气温变化的因素后，张力杆可吸收超过3t的张力。使用极细的杆可防止视线被阻碍，从而产生一种凉爽、明亮的外表。

4 日本式的综合性项目交付（IPD）

我们实施“生物外皮”项目的方法可称之为日本式的综合项目交付（IPD）。鉴于需要设计出部件来实现这一新型高性能建筑，Nikken Sekkei作为设计公司与几家制造商一起开发出了必要的新技术，并推荐了在绩效和费用控制方面首屈一指的制造商。这一程序成为新技术被成功采用并实现的原因之一，多家大学研究机构的配合也使得我们能够通过重复模拟和利用量化的数据来进行技术开发。（Nikken Sekkei/译，朱晓琳/校）

the measured data, indicated that the BIO SKIN’s surface temperature could be 10ºC lower on the hottest day in the summer, while the airflow analysis showed that the BIO SKIN wall could help reduce the temperature in the surrounding walkways and the entrance hall by 2ºC. Temperature near the glass surface of the exterior wall equipped with BIO SKIN is also 1–2ºC lower at each floor, proving the effect of reducing air conditioner use in the summer. We concluded that the resultant 2ºC reduction in the surrounding temperature should be a feasible target, given the fact that the heat island effect has raised Tokyo’s annual average temperature by 3ºC, which is 2ºC higher than the rise of only 1ºC in other cities.

(3) Problems of mold, moss, ice jams, and clogging

Mold and moss tend to grow on terra cotta, which has a high water absorption rate. This problem has been solved by a coating of a photocatalyst (titanium oxide; TiO_2) on terra cotta louvers and installing louvers with sufficient in-between space in a well-ventilated area. The high water absorption rate also can cause ice jams in the winter. This has been solved by shaping the louver symmetrically with a certain thickness, which helps disperse the expansion and contraction stress caused by freezing water. In addition, the extrusion molding method tends to make the material’s surface dense and cause clogging. In order to prevent it, scraping off of some of the skin of the surface layer has been added in the manufacturing process.

(4) System and equipment (water supply and drainage, sensors)

The BIO SKIN uses rain water. Rain water is collected from the roof, stored in the basement storage tank, filtered, pumped up, and supplied to the BIO SKIN of each floor. In case continuous clear days result in a shortage of rain water, clean water can also be used. We have also installed environmental measuring sensors and established the system that allows monitoring of the cooling effect by the Building and Energy Management System (BEMS).

(5) Tension structure support system

The tension structure has been applied so that the BIO SKIN is supported with the minimal components. The tension rods can absorb tensile force of over 3 tons, with due consideration in temperature change. Use of extremely thin rods prevents obstruction of vision, while the SKIN provides a consistently cool and light appearance.

4. Japanese Style Integrated Project Delivery (IPD)

The way we proceeded with this BIO SKIN project can be called Japanese style Integrated Project Delivery (IPD). Given the need to design components for realizing this new high-performance architecture, Nikken Sekkei, as the design firm, developed the requisite new technology jointly with several manufacturers, by occasionally making some to compete with others, and recommended the manufacturers which excel in controlling performance and costs. This procedure was one of the reasons behind successful adoption and realization of the new technology. Another reason for success was the collaboration of some university research institutions. This has enabled us to develop the technology through repeated simulations and use of the quantitative effect data in hand.