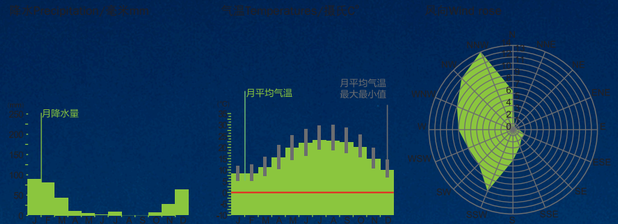


回应气候的绿色建筑 CLIMATE-RESPONSIVE 6/6

热带沙漠气候 DRY-ARID CLIMATE

ABU HINDI PRIMARY SCHOOL, PALESTINE

巴勒斯坦 Abu Hindi 小学

Design
ARCò - Architettura e Cooperazione
Material courtesy of
ARCò - Architettura e Cooperazione, Holcim Foundation
Edited by
谢莹

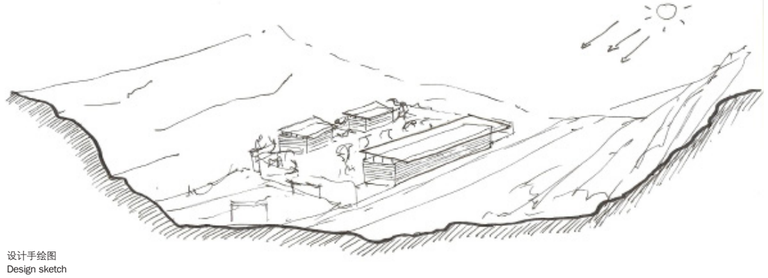
地点 Location
贝都因营地，东耶路撒冷，巴勒斯坦占领区
Wadi Abu Hindi Bedouin Camp, East Jerusalem, Occupied Palestinian Territories
建筑面积 Gross area
320 m²
造价 Cost
120 000 EUR
完成时间 Completed
第一阶段 First phase: 2010.07 — 09
第二阶段 Second phase: 2010.11
第三至第五阶段 Third phase to fifth phase: 2012.10 — 2013.01
年能源使用量 Annual purchased energy use
无 Nil
年碳足迹 Annual carbon footprint
无 Nil
功能 Function
教室，管理室，教师办公室，厕所，操场
classrooms, manager room, teachers' room, library, toilets, outdoor playground
绿色认证 Certificate
无 Nil

photo **Andrea&Magda**

这个位于沙漠中的贝都因族群的小学原本是由金属铁板围成的简易建筑。
建筑师和当地居民合作，在无法改变建筑结构的限制下，利用当地竹材、麦秆和泥土
在最短的时间内将其改造成一座舒适的绿色小学

ABU HINDI PRIMARY SCHOOL USED TO BE A METAL BUILDING WITH INADEQUATE INSULATION. UNDER THE RESTRICTION OF MAINTAINING THE EXISITING STRUCTURE AND MINIMUM TIME FRAME, ARCHITECTS COLLABORATED WITH LOCAL COMMUNITIES TO REFURBISH THE SCHOOL INTO A COMFORTABLE, SUSTAINBLE EDUCATION BUILDING USING BAMBOO, STRAW AND MUD

对页：学生在操场玩耍。部分儿童需要徒步一个小时才能抵达学校。
本页：设计着重于两个方面：建筑的外墙保温及屋顶的自然通风
Opposite page: students playing in the school compound. The children in Abu Hindi have up to an hour's walk to get to school in some cases.
This page: the design is focused in particular on two aspects of the school building: the external walls and the roof



设计手绘图
Design sketch

项目背景

巴勒斯坦占领区 Abu Hindi 的贝都因（Bedouin）族群共有约 2 700 人，由约旦河西岸及耶路撒冷南部的两大主要营地以及多个独立的居民群体构成。Abu Hindi 地区处于以色列聚集地 Maale Adumim 的南部，位于半沙漠地带，毗邻季节性河床，该地以南是基达（Qedar）族群聚集地，基达族对所有的贝都因人都持敌对态度。

这里的沙漠环境极其恶劣，高温和险恶的地形让贝都因人很难生活下去，而现在该地区还受到以色列军方的控制和威胁。项目营地位于当地最大的垃圾场下游。夏季时，河床边的一个泥浆池会产生瘴气，气体顺着风向对周边村庄造成污染。因为羊群吃的是附近山丘区域的草，有毒物质通过羊奶会进入到当地居民的食物链中。当地供水则是通过一根直径 2 厘米的耐用橡皮管实现的，但橡皮管经常受损。

本页，左上，顺时针：贝都因小学曾经是由金属板围合而成的简易结构。图中展示建筑改造工程的情况：建筑改造初期；意大利建筑团队人员爬上建筑的支撑结构，与当地居民合作建造；教室内部结构改造，墙体采用了竹材，因为竹材具有很好的透气性；教室地板结构的建造。
This page, left, clockwise: Abu Hindi primary school used to be a simple steel structure with metal panels. The images show the construction process with building structure exposed; architects from ARCò collaborate with locals for the construction; the facade design opted for panels made of bamboo as air can circulate between them and the metal wall; the flooring of classroom.

本页，左图：新学校创造了室内外的舒适环境。**对页：**教室入口
This page, left: the new school creates comfortable environemnts both indoor and outdoor. **Opposite page:** classroom entrance

沙漠小学
Abu Hindi primary school

建筑师 Architect
ARCò - Architettura e Cooperazione
赞助者 Promoter
Vento di Terra Onlus
当地协作方 Local partner
Jerusalem Bedouin Committee
Anate
使用者 Recipients
130 名 6 至 11 岁的学生，14 名教师，1 名校长，贾哈林贝都因社区
130 children 6-11 years old, 14 teachers, 1 headmaster, Jahalin Bedouins community
使用材料 Material
竹材 Bamboo — 500 m^2
麦杆 Straw — 3000 kg
石灰粉饰
Lime plastering — 325 m^2
泥土 Soil — 20 m^3
夹层板
Sandwich panels — 314 m^2
木制铺面材料
Wooden pavement — 180 m^2
钢结构
Steel structure — 5 x 5, 810 m
麦秆固定的土砖
Straw-stabilised soil bricks — 120 m^3 per 15 600 kg

因此，水资源经常被垃圾场和池塘里渗漏的泥浆污染，这种情况在冬季降水时经常发生。由于 Abu Hindi 地区没有供电网和电话，该社区使用租借的柴油发电机发电，但它不能既满足当地居民的需求，也无法持续进行发电。
当地居民早已习惯了周边的动乱以及军事行动对个人财产的损坏。他们是当地大规模迁移的受害者。1997 年，居民们想要为自己的孩子建一所小学。但是由于被视为“游民”，军队不允许他们建造新的永久性建筑，而他们自己也没有建造经验。最初居民们建造了一栋大约 20 平方米、共有七间房屋的简易学校，由于他们能够找到的材料非常有限，所以不得不使用大量的镀锌铁板进行建造。学校已经被摧毁过三次，孩子们在高达 50 摄氏度的金属铁墙内上课，他们对“货物集装箱”教室已经变得习以为常。
“在学校后面有一个驴圈。对于那些每天都要走很远的路程来上学的孩子来说，驴子是他们的交通工具。在这里教育仍然像是一项特权，而不是基本权利。”学校协调人 Inam Waheidi 说道。

沙漠小学

2010 年，Vento di Terra NGO——来自意大利米兰的非政府组织了解当地情况后决定帮助当地居民改善学校条件。这个非营利组织邀请了由年轻团队组成的 ARCò 事务所进行建筑的设计与改造工作。
然而，“沙漠小学”项目面临着以色列军事当局施加的特殊限制，当局认为应该维持现状，不允许对现存学校建筑体量做出任何改变，其既无法满足功能也无法正确应对当地气候条件。建筑师在有限的条件下，希望将建筑改造成为舒适并可以自给自足的绿色小学。设计着重于两个方面：建筑的外墙保温及自然通风。初步改造完成后，建筑师还意图利用雨水收集系统和太阳能板取代村民对柴油发电机的依赖。
设计将降低室内温度作为首要考虑因素。“我们想要利用可拆卸的材料遮住金属墙体，这样改造不会影响建筑本身的结构”，建筑师 Claudia Romano 如是说。ARCò 事务所选择使用竹材，因为竹材具有极佳的透气性。同时建筑师将墙体加厚，以提升其保温性能。他们利用多层竹胶板作为框架，使用稻草和泥土在竹板上涂抹填充，最后经过粉刷，成为介于金属外墙和教室之间的保温墙体结构。虽然墙体的加厚意味着整个教室的面积会变小，但是室内的隔热效果会大大增加。经过改造后，建筑的墙体厚度共为 34 厘米，金属板内是竹材、稻草和泥土组成的内墙；金属板外则是由竹材编制、用于遮阴的外墙，在竹墙和金属板之间还保持一段距离，使空气得以流通。室内墙壁的隔声效果是通过在现有教室之间修建新墙来实现的。现存的金属片被稳定的土壤砖取代，砖材由约旦河谷的当地工匠生产，并最终用白色的石灰粉饰覆盖。
自然通风利用将屋顶升高并且稍加倾斜得以实现。屋顶分别在东墙升高 30 厘米、西墙升高 60 厘米，中间可以利用滑动式的有机玻璃板拉开或关闭，室内空气得到了有效的流通。屋顶的改造让建筑师重新思考整个教室围绕钢结构的设计，而钢结构是整个建筑中唯一由专业建造公司完成的部分，其余都是由当地村民完成建造。
由于建造工作只能在学校放暑假期间进行，工程必须在两个月内完成。所有工人都是本地村民，他们平均每周工作六天，每天共有八人进行施工。两种来自不同文化的融合——意大利建筑师和贝都因人的协作，并不是全程顺利。但是，建筑师 Claudia Romano 告诉我们，结果总是“每人都可以向对方学到新的东西，然后共同协作创造最佳的效果”。学校协调员 Inam Waheidi 也认为“建造帮助了人们了解如何使用可回收材料，他们能将这些知识运用于自己的家园同时学到新的材料知识。”新教室为学生带来了福祉：学校在夏天的室内温度至少比室外低五度，和以前的温度相比可谓天壤之别。虽然新的建筑也并非完美，比如室内的粉刷很快就需要再次修复。不过即使如此，新学校已经成为典范——世界其它类似条件地区的建筑需要像“沙漠小学”一样，在经费和时间严格限制下，利用在当地可行的设计与技术实现能够改善居民条件的公民建筑。
2010 年 9 月，新学年开始，“沙漠小学”迎来了 130 位来自周边地区的贝都因学生。2011 年，该项目被授予瑞士 Holcim 基金会可持续建筑大奖（非洲与中东地区）的银奖。2012 年 8 月，Vento di Terra 组织在多家联合国人权机构和比利时协会的资助下，得以运作项目余下三个阶段的重建工作，并于 2013 年 2 月完成。这部分工作的第一步包括教师办公室的重建，而当办公室屋顶建好后，上面可安装太阳能板。事实上，此项目的余下工程都是采用太阳能供电，包括将一座金属板围合而成的储藏屋改造成两间教室，作为新学年设立的两个年级的学习空间。同之前一样，建筑师与当地居民同心协力，利用当地天然材料（稻草、泥土、沙、木材、竹材等）和工业材料（金属屋顶、木地板）进行建造。
在项目的最后阶段中，建筑师在教室周边及通向教师办公室的路上都进行了硬面铺设，并采用干石墙系统加固了围绕坡地的三面土墙。新设的花园操场拥有三个滑梯、秋千、喷泉、室外活动设施和供孩子们玩耍的空间。这部分的公共设施对社区及教育系统都非常重要，它们将成为学生们每日生活的一部分，让当地学生可以和世界上其它地方的孩子一样，在学校享受快乐的童年。

Social and territorial context

Abu Hindi Bedouin community is composed by two main camps in the South of Jerusalem, West Bank, and several isolated groups, for a total of 2,700 people. Abu Hindi is south of Israeli colony called Maale Adumim, in a semi-desertic region next to a seasonal creek bed. On the southern side of Abu Hindi there is Qedar colony, which is hostile to all Bedouin communities in the area.

The deserts area is very harsh to live in. Fierce heat and hostile terrain made life a struggle for Bedouin inhabitants and now they are subjected to the restrictions and dangers of Israeli military control. The camp is downstream of the biggest dumping ground in the area, which is used both by Jerusalem city and Israeli colony. A slurry pool, right close to the creek bed, during summer causes miasmas going towards the village and making air unbreathable. Water supply is realized with a service rubber pipe of 2 cm diameter, often damaged with infiltrations. Abu Hindi has no connection with the electric net and the phone net. The community uses a hired gas oil generator, which is unsufficient and cannot work in a continuous way.

The Abu Hindi community have grown accustomed to the persecution and routine demolitions of their property. In 1997 the inhabitants of Abu Hindi decided to build a primary school for their children. As "nomads" were not allowed to build a permanent structure for the school and they had little experience or resource in the construction of fixed installations, the building of seven 20m^2 rooms were built with sheets of galvanized iron. Three schools have been destroyed since then.

Desert school

Vento di Terra NGO— a Milan-based non-governmental organization— learned of this untenable situation the people at decided to do something about it. In this endeavor of upgrading an unchanged structure, has the support of ARCò Architettura e Cooperazione, a northern Italian cooperative of young, idealistic architects.

本页上图: 新学校为当地学生带来了福祉，教室在夏天的室内温度至少比室外低五度，和以前的温度相比可谓天壤之别。**对页下图，从左至右:** 建筑师利用多层竹胶板作为框架，使用稻草和泥土在竹板上涂抹填充，最后经过粉刷，成为介于金属外墙和教室之间的保温墙体结构；教室一隅

This page, above: the new school created comfortable studying environment for the children. The temperature in classrooms is about five degrees lower than the outside during summer, no longer resembling the old "metal-box". **Opposite page, from left to right:** the architects attached a multilayer wall made of straw and mud to the inside of the existing external wall of metal sheeting and plastered it; classroom corner

The "Desert school" project faces particular restrictions imposed by the Israeli military authority, that state impossibility of volumetric reshaping for the existing school building, which didn't fit its function nor could answer in a correct way to the local climatic conditions.

Technical and architectural decisions have the purpose of retrofitting the existing building and transforming it in a new one. The design worked on two main themes: thermal insulation and natural ventilation, thinking to a second project step with a rainwater collecting system and a photovoltaic plant, to substitute the actual gas oil generator.

The first objective was to substantially reduce the temperature in the classrooms, which could reach 40 degrees in summer. "We wanted to shade the metal walls using easily removable panels that do not alter the building," architect Claudia Romano explains. ARCò opted to design panels made of bamboo as air can circulate between them and the metal wall. At the same time the architects searched for a way to insulate the walls. They decided to attach a multilayer wall made of straw and mud to the inside of the existing external wall of metal sheeting and plaster it. Although this meant that the individual classrooms would be slightly smaller, they would be much better insulated. The final result in the school is a wall 34 cm thick, including lime plastering, bamboo panels as quarterdecks, soil and straw layer, existing external metal sheet, air cavity and a final external shading bamboo panel. ARCò's solution for acoustic barriers between the classrooms was partition walls made of mud bricks; a wooden floor further enhanced the insulation. The existing metal sheet was substituted with stabilised soil bricks, produced by local artisans in the Jordan Valley, finally covered with a white lime plastering.

Natural ventilation was created by raising and tilting the roof, thus realizing an efficient air circulation system. New openings are 60 cm high on the west side and 30 cm high on the east side, and can be closed with sliding plexiglass panels. The creation of new openings led to rethink the whole steel structure, which is the only part of the building which was realized by a specialized building company.

All works were realized in two months, six days par week, eight workers par day, all workers coming from the village. Thus works took place only during the summer school vacation, working hard in July, which is the month before Ramadan period in 2010.

The two working cultures – ARCò's and the Bedouins' – were not always immediately compatible, but, according to Claudia Romano, the result was always "a cooperation in which all the persons involved were able to learn from one another." School coordinator Inam Waheidi also mentioned "It helps people to understand the use of recycled material. They can use this knowledge in their homes and become familiar with new materials." Ultimately, the concept proved to be as successful in practice as in theory: In summer the classrooms are now about 5 degrees cooler than outside and there is no comparison between the former and the current indoor climate and ambience. However, not all problems have been solved by any means. It turns out that the plastering on the interior walls has to be improved as it does not stand up to ordinary wear and tear. That said, the school is already a beacon – similar projects in particularly critical parts of the world need cheap and easily realizable technological solutions of the kind that the Abu Hindi project proves are feasible.

On the 14th of September 2010, the school year 2010/2011 was opened with 130 students coming from the Jahalin Bedouin villages in the Al Azarije area. In 2011, the project was awarded Holcim Awards Silver prize, Africa Middle East section for sustainable projects in developing countries.

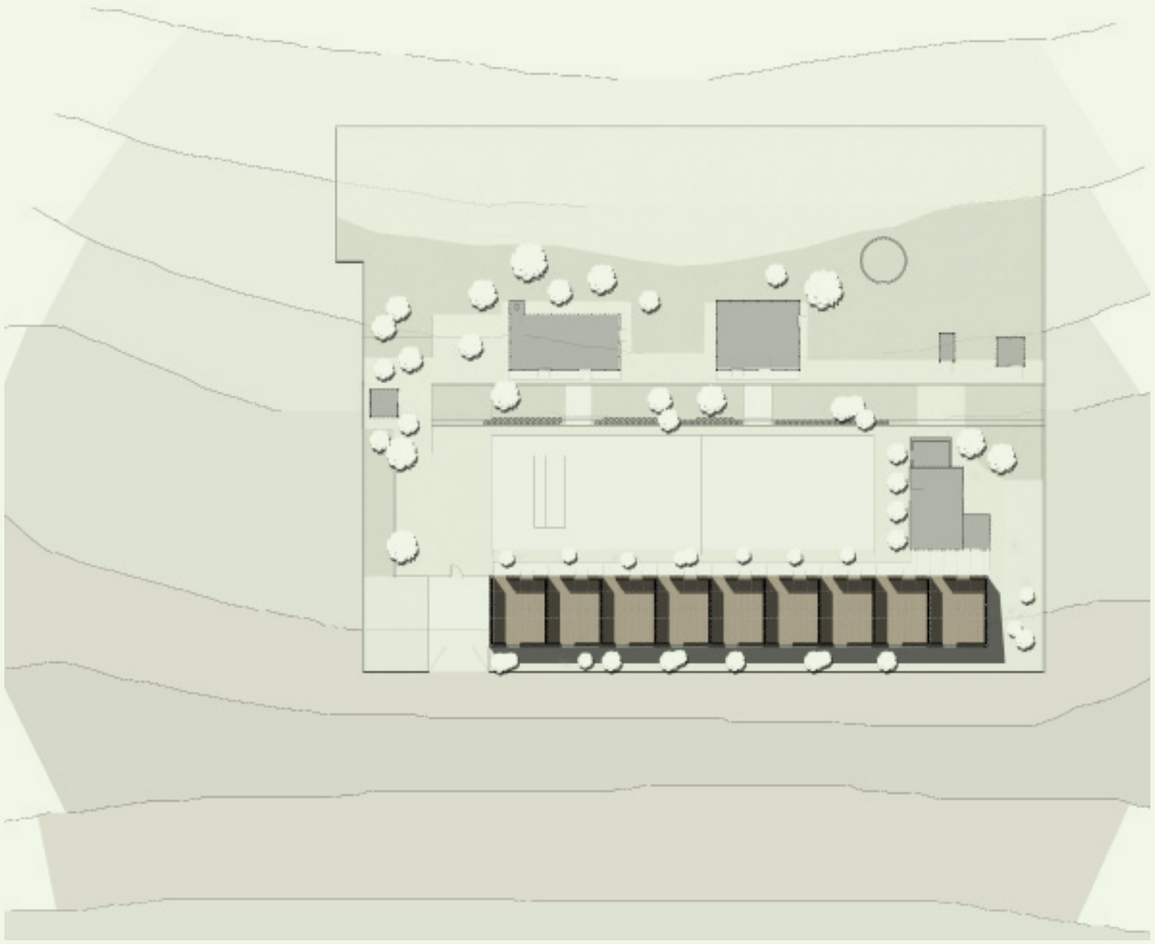
In autumn 2012, Vento di Terra got the approval for three more phases of rehabilitation works, thanks to funds received from several UN humanitarian agencies and the Belgian Cooperation, so a new calendar of intervention was established in order to complete the renovation of the whole school compound, achieved last February 2013.

As a first step, the offices of the teachers' team and the school's director were rehabilitated using the same techniques implemented two years before in the nine classrooms. Once both offices' new roof was set, it was also possible to install a photovoltaic system over the teachers' office. The solar powered electricity provided by the new system was already used for the implementation of the following works, consisting on the substitution of an existing storage barrack by a new pavilion hosting two new classrooms, the 10th and 11th, which from next school year will extend the educational service of Wadi Abu Hindi school incorporating two new grades.

On this last stage the works consisted among others, on the installation of a hard pavement around the classrooms and connecting them with the teacher's office, the stabilization of the sloped areas (very deteriorated by the rainfall effects) with the construction of a system of dry stone walls and garden terraces which incorporate also three slides, and the installation of new swings and playgrounds, fountains and exterior furniture.

This common part is very important for the community school life and the teaching system and it become the central element of the everyday life of the students, giving the aspect of a real school as everywhere in the world.

绿色分析 Green Analysis



平面图
Floor plan

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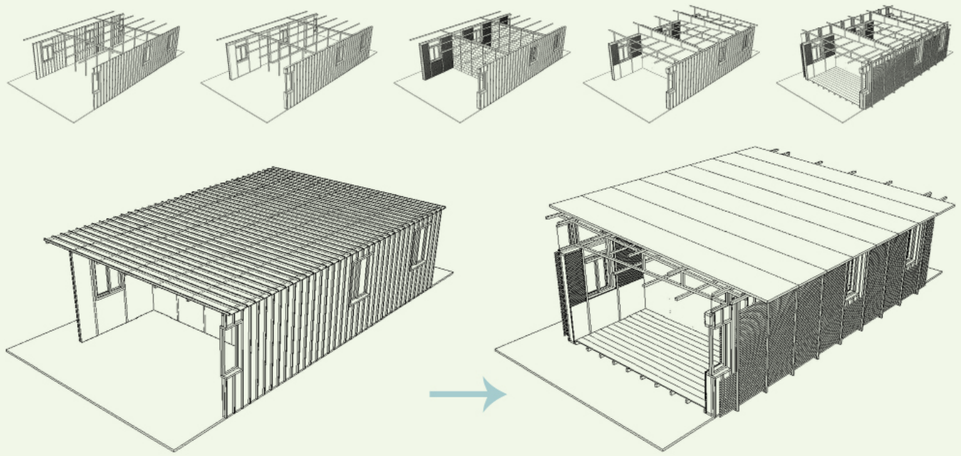
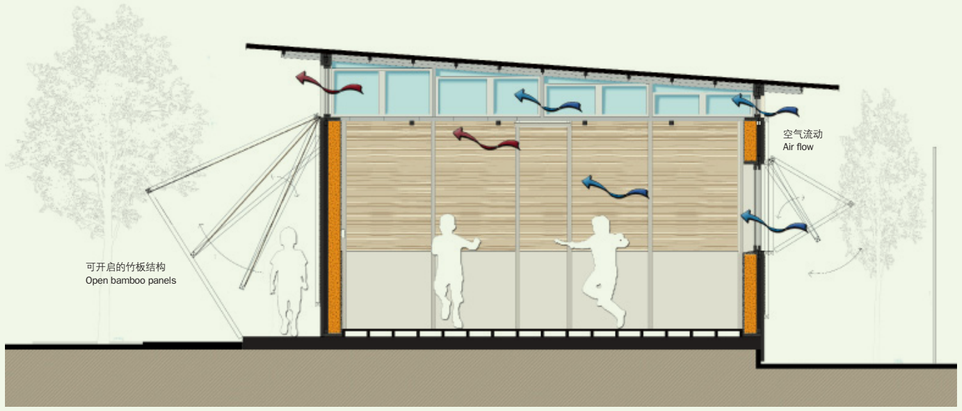


建造过程示意图
Construction process

隔热墙体结构分析
Thermal insulating ventilated wall

南立面上可移动的竹板结构
Mobile bamboo panels on southern facade



教室通风示意图
Classroom ventilation