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下寺村新芽环保小学，广元剑阁县，四川，中国
XIASI NEW BUD ECO SCHOOL, JIANGE, GUANGYUAN, SICHUAN, CHINA, 2009

建筑设计：朱竞翔，夏珩
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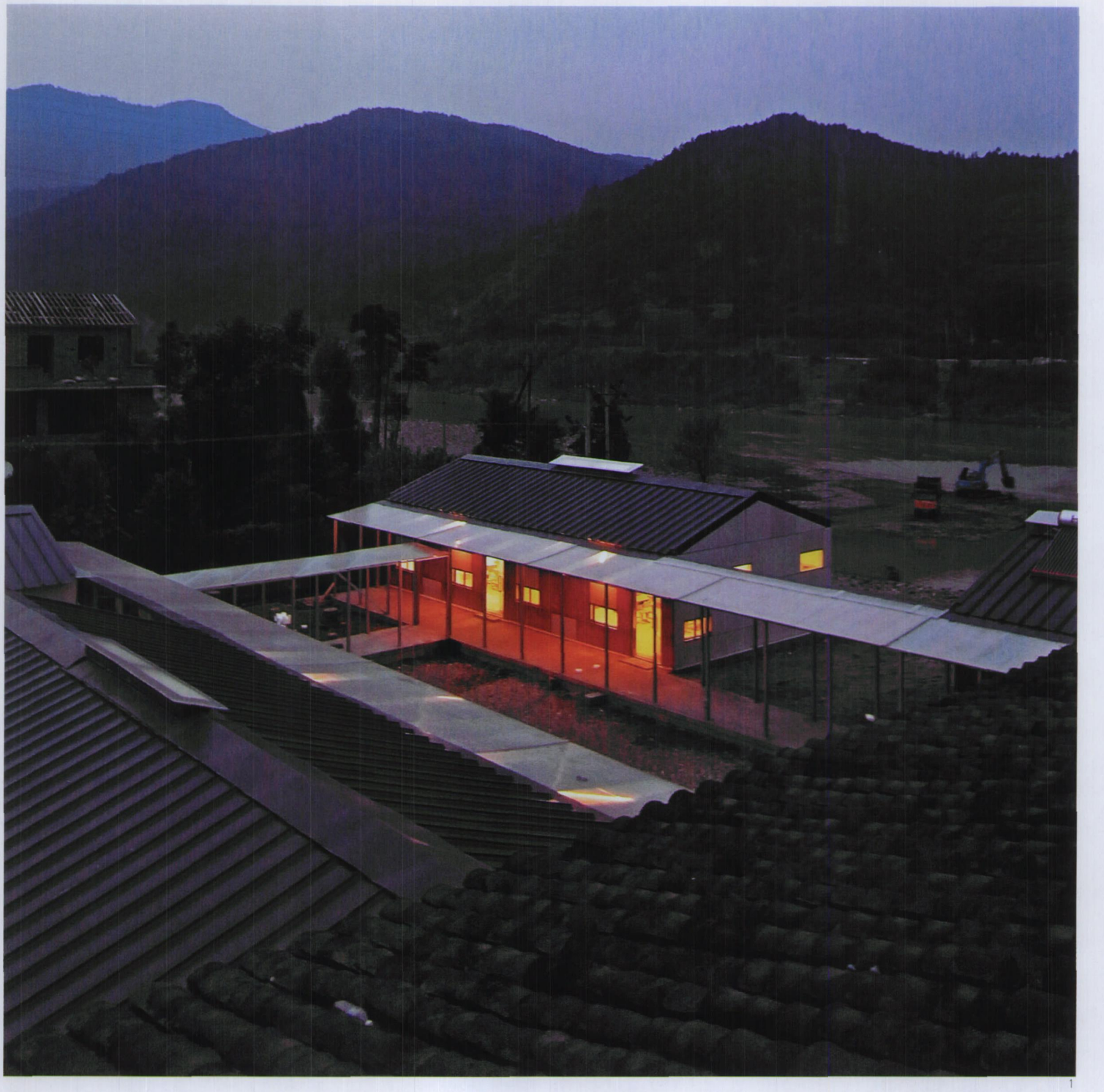

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评语 /Jury Comments：

该小学的重建不仅是一项综合了结构体系、环保考虑、社会经济等诸方面因素的系统化的研究成果，也体现出该设计对具体基地的适应性和人文关怀。对我国广大农村地区和灾后学校的重建具有重要的借鉴价值。□

The project is a result of systematic research that encompassed structural and environmental concerns, and social-economical aspects. The design shows its adaptability to the specific site and cultural issues. It could be a significant reference for the reconstruction projects in Chinese rural areas after an earthquake.□

学校规模 /Capacity：乡村小学，含 5 个教室、办公室及 1 个厕所及浴室 /Village School with 5 classrooms, office, 1 toilet and 1bath

师生人数 /User：280 名学生 + 5 名教师 /280 students + 5 teachers

建筑面积 /Total floor area：437 m^2 (室内 347 m^2，廊道180 m^2)/437 m^2(Indoor area: 347m^2, Corridor area: 180m^2)

建筑容积 /Total volume：1 040m^3

建筑造价 /Total cost：RMB 1 300/m^2

建造 /Builder：8 名专业工人，10 名村民，30 名大学志愿者/8 Workers plus 10 Village Workers & 30 University Volunteers

结构系统：LGS 轻钢骨架与填充板材形成的复合结构

施工耗时：房屋结构 14 天，基础准备与场地清理 44 天

节能性能：完整绝热构造 + 自然采光优化设计 + 尿粪分离厕所

环保性能：房屋可整体拆卸异地重建，地坪使用建筑废料建造

抗震性能：可以抵御麦加利地震裂度10度（经由香港大学土木工程学院测评）

System: LGS skeleton strengthened by Rigid Board

Construction Period: Superstructure 14 days, Base & Landscape 44 Days

Comfort: a Full Insulated Envelope + Optimized Daylight use + Eco Toilet

Sustainability: a Demountable System, Paves made from refused materials.

Earthquake Resistance: (Mercalli intensity scale) Degree X (Evaluated by Civil Engineering Department, Hong Kong University)

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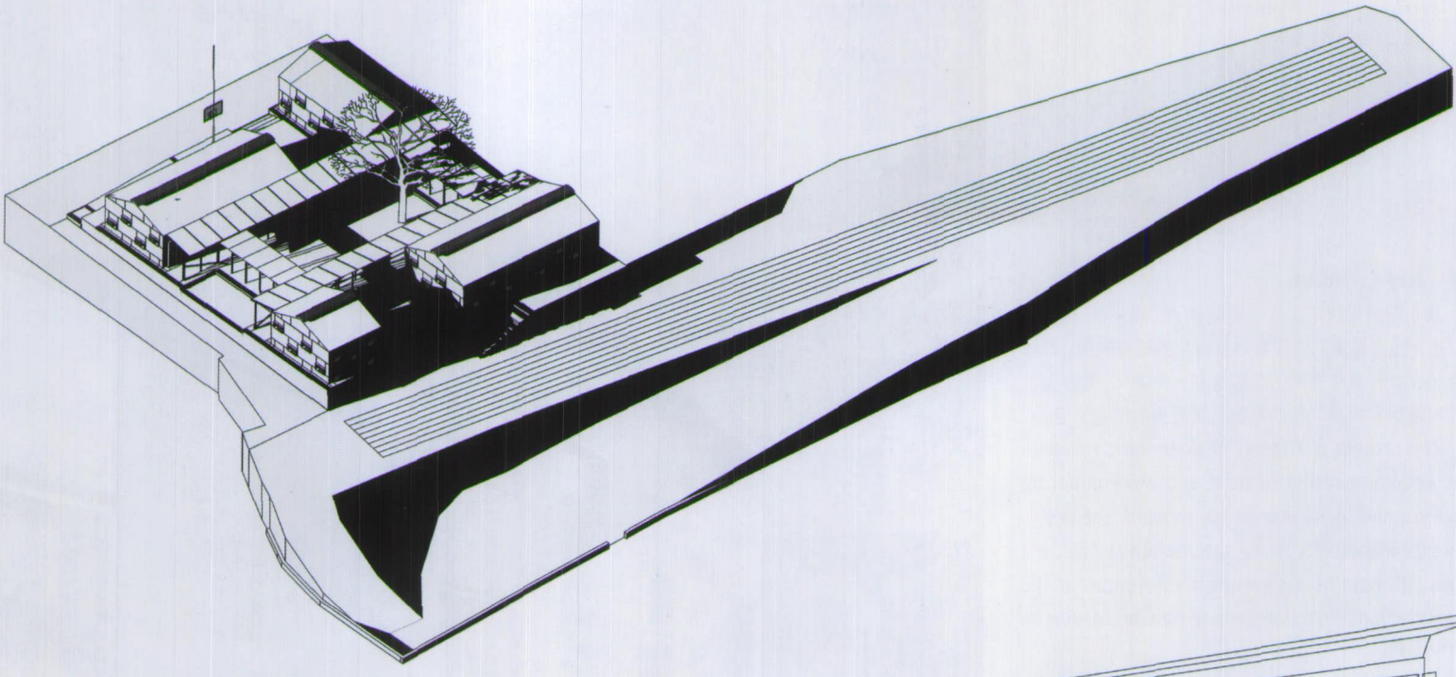

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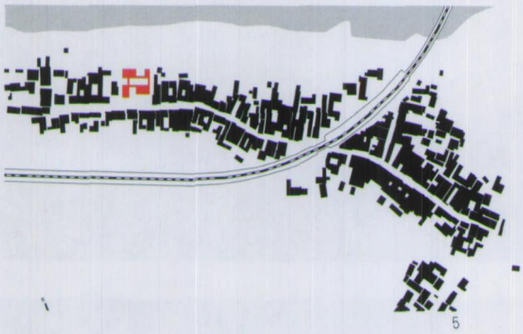

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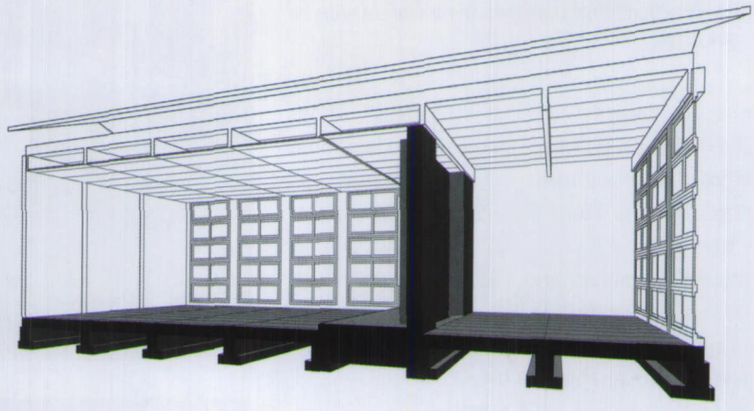

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“5·12”汶川大地震使四川广元剑阁县下寺村新芽小学顿成危楼，学童需步行穿过铁路桥或重型卡车混行的公路，耗时两小时到镇中心小学上课。得到香港慈善基金会捐助，下寺村小学计划重建450m²校舍，用以容纳幼儿园及1－3年级教学。

大地震揭示出部分建筑物缺乏良好的结构设计与施工监管，而重建的许多楼房继续沿袭旧有的重型构造，只是多加钢筋与水泥，设计并不完善与可靠。雷同的建造手段也带来建材价格急升。与此同时，各地援助的救灾活动房却由于舒适性不佳而被大量弃用，在灾区产生新的建筑垃圾且浪费资源。

根据早期的研究积累，设计师确立重新设计研发轻型钢框架系统的方向：保留系统快速建造的特性，重点提升物理性能——特别是热物理性能。通过围护改造提升整体结构刚度，改善外观。

经过约8个月的研究、设计与试验，校舍上部结构建造在2009年8月花费两周完成，且每平方米造价与当地新建民居相近，有广泛的适用性及作为类型推广的可能。

通过研究新校舍与村庄及周边环境的关系，设计师发展出新的校舍布局，4栋单元组合由连廊串接在一起，界定出内向的院子。在村庄街道一侧，凹凸的形态强化了校园的入口。房屋之间的空隙可将人们引向另一侧的河滩坡地。

4个单元分别提供了不同尺度的内部空间，可以方便地布置教室、多功能室以及办公室，最小单元用于设置卫生设施。连廊提供了全天候使用的室外空间，也能成为非正式课堂教育的一部分。村校如果由于收生减少而被关闭，分散布局的校舍仍可灵活地转换为活动中心或者老人中心。新校舍采用1.82m的平面结构模数，既应对房间、开口等功能要求，亦方便围护材料的分配与裁切。此模数也用于规划外部空间。

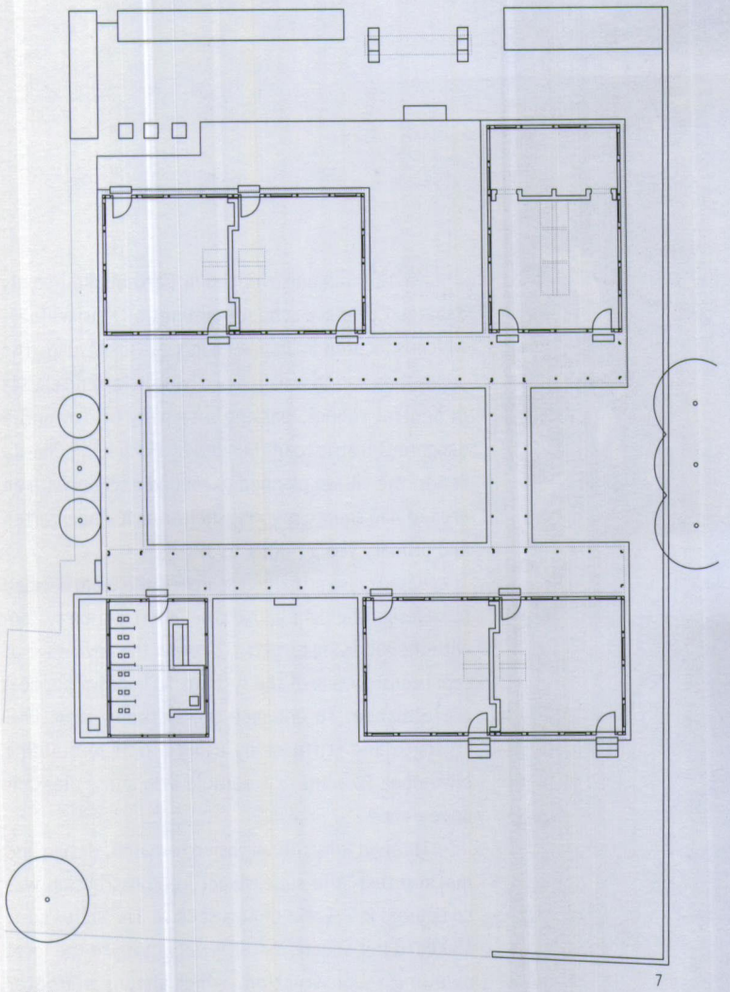
房屋系统由轻钢框架与围护板材共同构成复合结构。在钢框架部分，两根C型钢龙骨反扣形成工字形构件，构成垂直立柱、连系梁或者水平桁架构件，再形成平行框格，整个结构通过既抗拉也承压的连系杆拉结，通过螺栓固定于地梁之上。围护板材在插入C型钢架后再通过加强板连结为整体，可以抵御很大的地震侧向力。框架连接多以机械方式装嵌，减少使用化学胶结剂，更便于维修、拆卸或移动。

钢框架完全被围护墙板覆盖而没有冷桥。围护墙板的最外侧由纤维水泥压力板或者有防水涂层的木模板覆盖，之间的空腔可以形成通风间层用以带走多余热量或湿气。室内外热交换被围护构造有效减少，室内隔墙用旧砖加筋砌筑，小学旧楼拆下的预制水泥板被用作地坪垫层，这样可利用材料的热惰性来稳定室内气候。

分散设置的小窗让房屋获得均匀采光。少许天顶开口能解决教室中央的光照问题。墙面开口分为高窗和低窗。低窗窗台位于0.6m标高，可向内完全开启，便于小朋友使用并为近窗侧提供光线，固定式高窗则为远窗侧提供光线。两者均采用中空玻璃加强隔热性能。

废弃校舍拆下的砖瓦和村民分拣的河中卵石、山石以传统工艺制成水磨石，形成别具一格的室内地坪。还有一部分旧砖瓦被用于室外场地的铺砌。这些强调就地取材、材尽其用的做法，传递出废料循环、保护环境的认识，借以鼓励当地工匠保留传统手工艺，减少对工业化建材的依赖。此外，太阳能热水尿粪分离式厕所设施与技术应用能够提升乡村生活的卫生水平。

校舍重建由8名工人、10位村民及30名来自香港及内地的大学生共同完成，并在随后的冬季测试中获得了令人满意的物理数据。□



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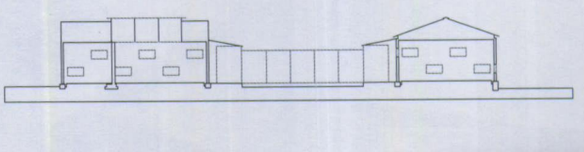

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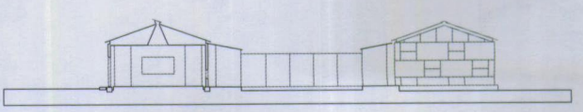

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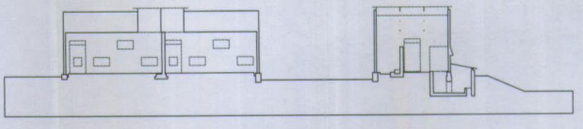

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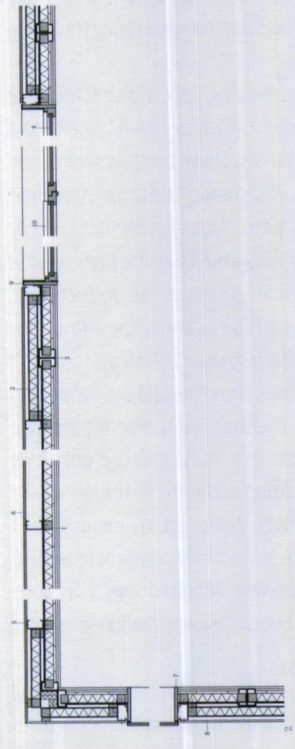

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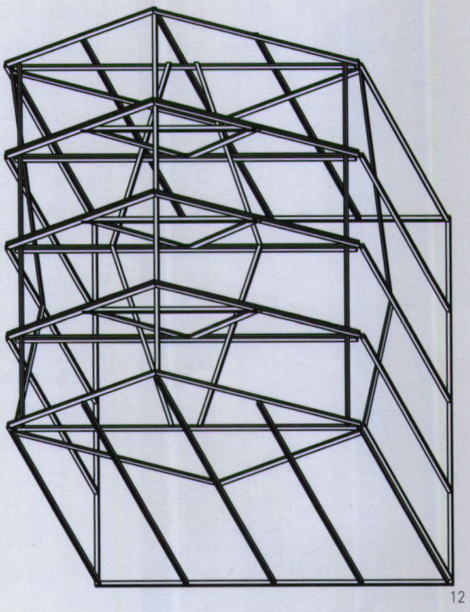

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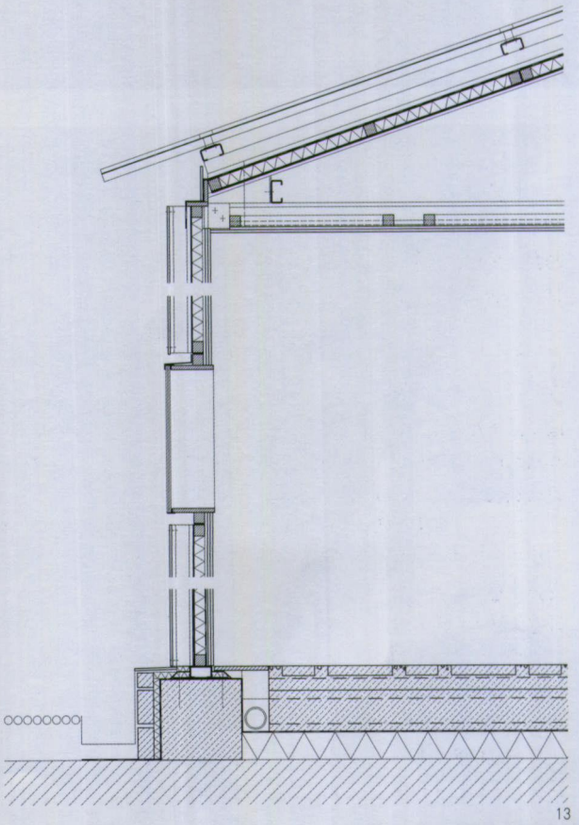

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"5.12" Sichuan Wenchuan Earthquake heavily damaged primary school buildings of Xiasi Village, which is located in Jiange county of Guangyuan. The pupils then had to walk for two hours to attend classes in central school, passing a railway bridge and a dangerous traffic road. Funded by Hong Kong Charity Funds, the village planned to rebuild a school with an area of 450 square meters, sheltering a kindergarten and primary years from 1 to 3.

Based on some early researches, the team decided to redesign the light gauge steel construction system with the following targets: To retain the advantage of rapid construction of the system; To improve physical performance; To enhance the system's structural strength and stiffness by using a unique building envelope; To achieve a durable skin and a pleasant appearance.

Through 8-month intensive research, design and mockup test, the superstructure construction was completed in 2 weeks of August 2009. The actual cost, 1300RMB per square meter is very close to the local dwelling reconstruction, which means a greater potential of the new system on wider application in developing areas.

The primary load-bearing part of the school is a light-gauge steel frame, which is strengthened by a prefabricated panel system. These two parts are bound together by mechanical fasteners to form a strong but light composite structure. Although the wall is only 16cm thick, the system is able to resist high seismic forces up to Mercalli scale X. Under the protection of the outer panel and surface coating, the life of the skeleton is expected to last over 20 years.

The school features high thermal performance, thanks to the use of thermal insulation and storage materials. It also adopts a multi-layered envelope system where the position and ratio of the doors and windows are carefully designed to ensure that classrooms will be cool in summer and warm in winter. The decentralized opening system brings in enough daylight and natural ventilation, which greatly reduces energy consumption.

Additionally, the design incorporates environmental concepts by mostly using mechanical

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joints instead of chemical compounds to avoid toxic emission and to facilitate maintenance and disassembly in the future. A solar water heater and an eco-friendly toilet are equipped to improve rural sanitation.

The principle of sustainability is also reflected in the choice of materials. Materials dismantled from the old school are reused as pave, spacer or thermal mass. Some of the stone bases discarded by the villagers are also reused to furnish the courtyard. Besides, no other materials except cement were purchased for construction. Old bricks, stones and tiles are reused to achieve terrazzo effects in the flooring. This encourages local workers to preserve and develop their crafts, while reducing dependence on industrialized building materials.

As all superstructure components are prefabricated in factories in Shenzhen and Chengdu, on-site assembly became an easy task. With a simple guidance, the 450-square meters New Bud Primary School was built within two weeks by factory workers, villagers and 30 university volunteers from Hong Kong and mainland. In the 2010 winter, a thermal test collected satisfactory data, which proves a successful realization of design intensions.□

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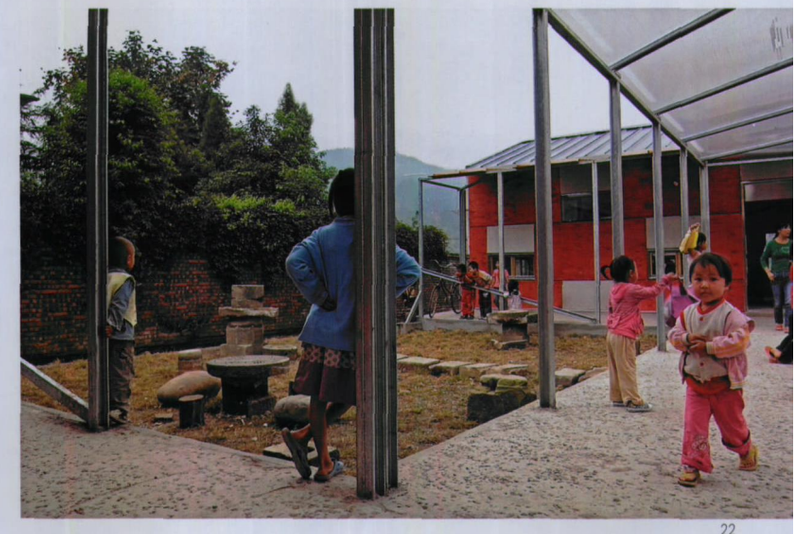

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