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中国西南乡村创新与可持续发展研究联盟作品集

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光明村震后重建示范

Post-Earthquake Reconstruction Demonstration Project of Guangming Village

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项目地点：中国云南省昭通市鲁甸县龙头山镇光明村

项目时间：2014 年

基本情况

在 2014 年鲁甸地震后，光明村大多数的夯土建筑都被摧毁了，之后村民想选择建造砖混结构的建筑。然而，建材的价格急剧上升，大多数村民已无法承担这样的价格。

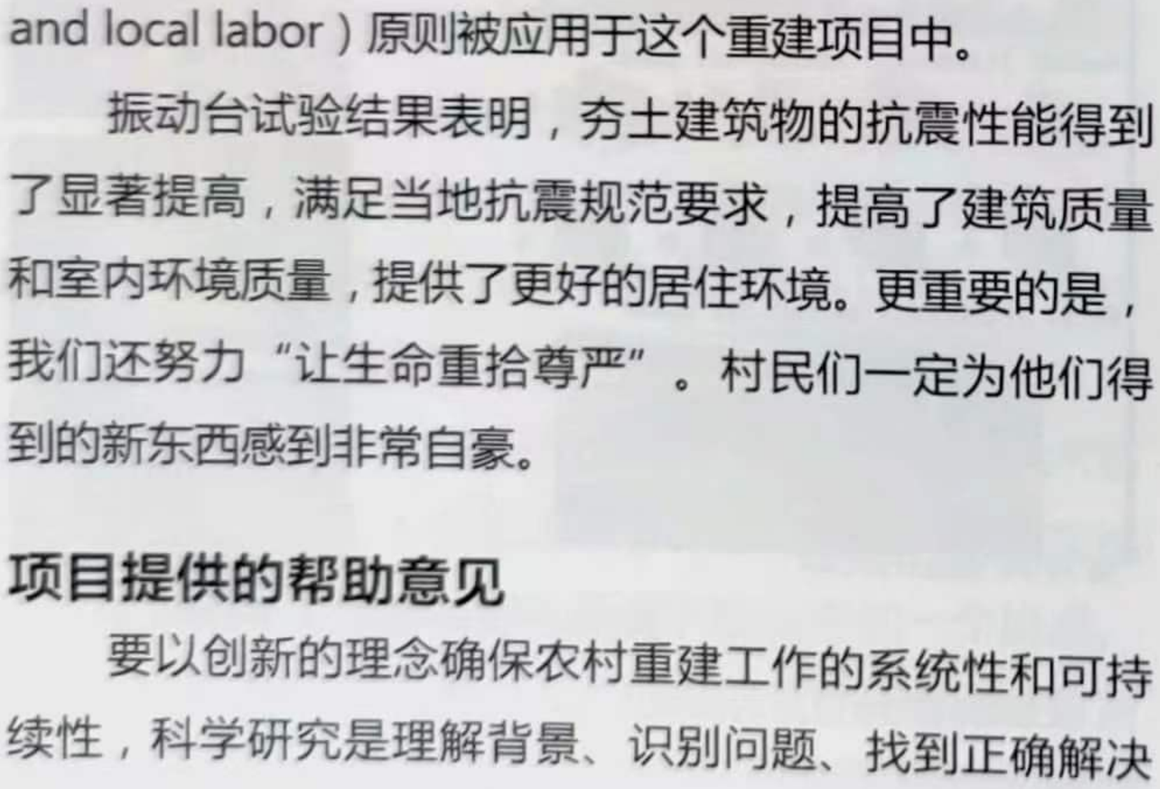
这个项目的创新点在于利用传统夯土建筑技术给村民提供可承担的、自己的、可传承的安全、经济、舒适和可持续性的重建策略。

为了验证新型夯土建筑系统的技术和建筑性能，我们为一对老年夫妇建造了一座样板房。“高科学性和低技术”的策略和 3L 技术（local technology, local materials, and local labor）原则被应用于这个重建项目中。

振动台试验结果表明，夯土建筑物的抗震性能得到了显著提高，满足当地抗震规范要求，提高了建筑质量和室内环境质量，提供了更好的居住环境。更重要的是，我们还努力“让生命重拾尊严”。村民们一定为他们得到的新东西感到非常自豪。

项目提供的帮助意见

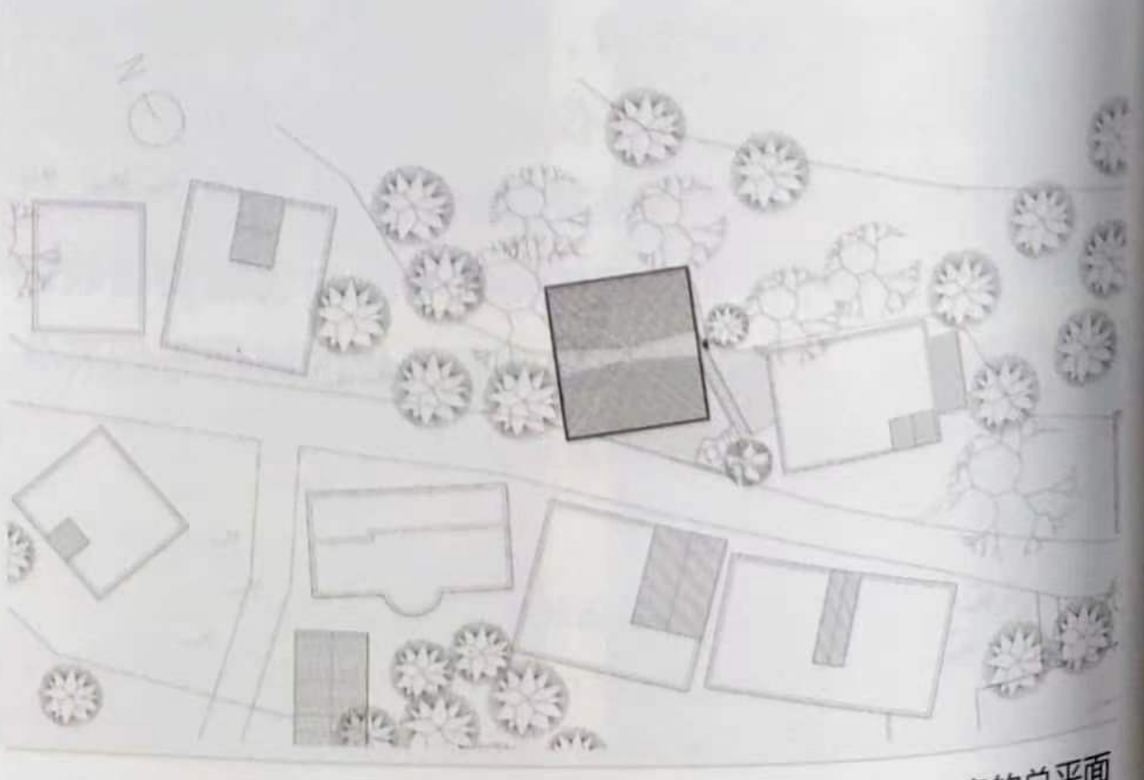
要以创新的理念确保农村重建工作的系统性和可持续性，科学研究是理解背景、识别问题、找到正确解决方案的关键。为赋予当地居民权力和鼓励内生发展，建



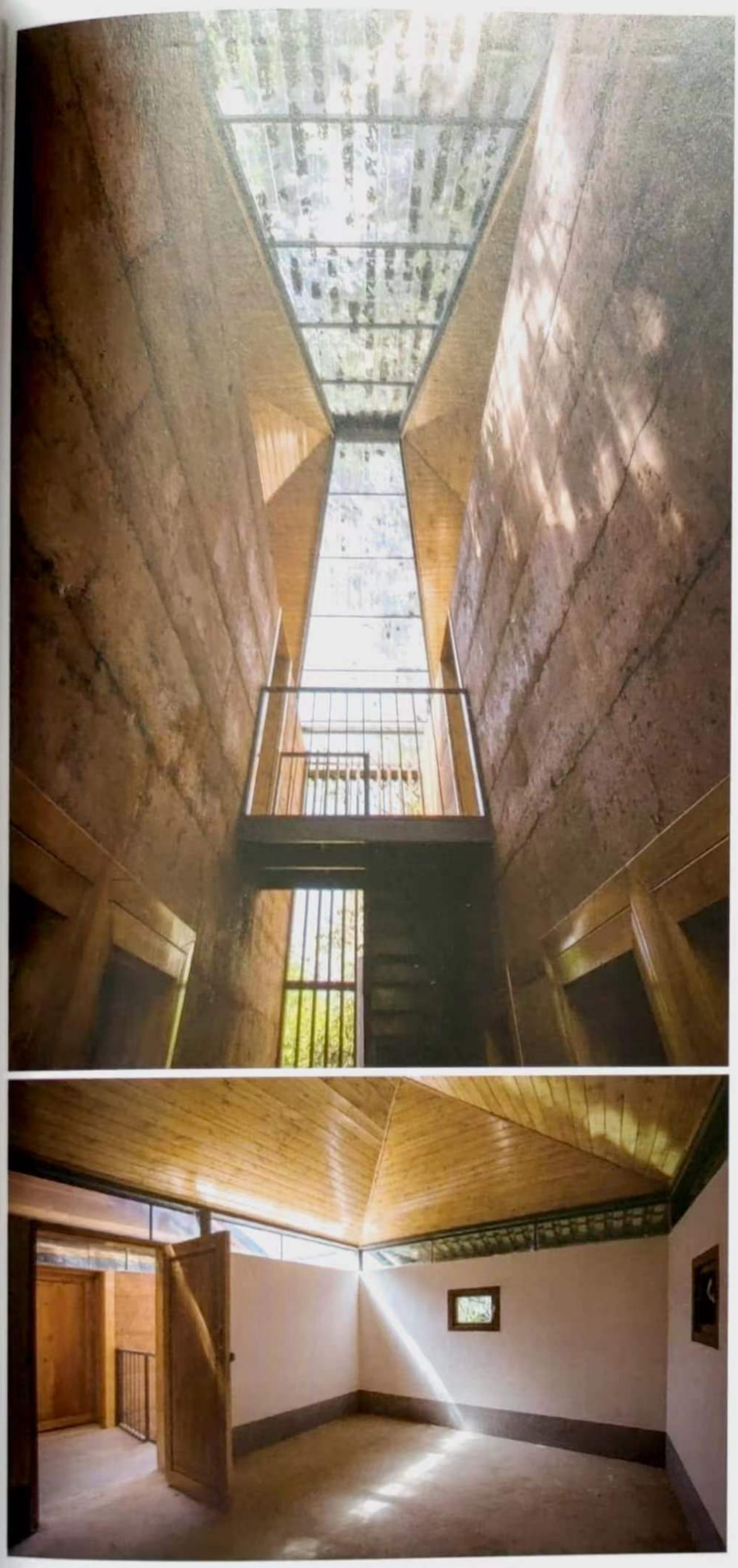
样板房

样板房的区位

议的创新技术应简单易行地传播给当地居民。应限制外部材料和劳力，以降低建设成本，改善当地市场。因此，“高科学、低技术”战略和“3L”原则适合我国西南贫困农村地区的国情。



样板房的总平面



样板房室内

房子的原型是为地震后住在帐篷里的一对老夫妇建造的。采用从废墟中回收当地材料的被动设计确保了舒适的室内环境和低能耗。设计融入半室外空间，为老年夫妇提供舒适、艺术的生活环境。带有天窗和交叉通风的半室外中庭明亮且自然通风。双层玻璃窗和隔热屋顶被用来提高建筑的热性能。采用钢屋盖结构和铝合金窗，提高建筑质量和密封性。

通过对当地传统夯土建筑薄弱环节的调查研究，提出了一些改进措施，以提高其抗震性能。适当的混凝土基础尺寸配以正确的水泥砂浆，增强房屋地基的整体性。场地土壤在昆明理工大学实验室进行了检测，并与砂、稻草、少量水泥进行了适当的调整，以避免裂缝，提高墙体的强度和防水性能。墙体增设混凝土环梁，提高结构整体性，避免竖向开裂。混凝土带隐藏在墙体中，这样土的立面就可以被整合。铝合金模板和电动夯使墙体结构紧凑、光滑。

我们没有推广进口砖和混凝土，而是选择是否可以就地解决传统夯土类型的不足和乡村生活的脆弱性。光明村改造的局限性包括贫困、交通成本高、缺乏技术、对失败的施工技术缺乏信心、可达性差、气候特殊性以及村民对比旧住宅更大、更好、更稳定的现代住宅的向往。所有这些标准在整个过程中都得到充分考虑和处理。该方案是根据该地区的地质和气候条件确定的。执行这项战略是重建人民生活的一个简单步骤。保护和创新当地传统夯土施工方法。通过这种简单的策略和当地居民的授权，夯土建筑的性能得到了改善，从而保护了村庄的生活方式。此外，我们试图保护这种建设方法和生活方式，因为云南有大量的村庄面临着维护传统建筑或应用工业建筑材料的选择。大量的农村土建被列为需要重建的危房。当地政府仍在寻找一个低成本的好办法，在不破坏其历史文化价值的前提下，提高乡土建筑的安全性和舒适性。该示范项目的建设不仅要与现有的周边环境相结合，而且要与云南农村的大背景相结合，展示一个内生的、可持续的解决方案。

团队贡献专业知识和先进技术，当地居民提供当地知识和人力。如果没有任何一方的努力，这个项目就不会成功。村民在整个重建过程中受到尊重并充分参与，除了建筑工程，他们还参与了新家的设计。在施工过程中，我们团队与村民之间建立了信任关系。保护和加强了当地的生活方式和施工方法。这个重建项目不仅重建了基础设施，还重建了村民的信心和归属感。

在这个项目中，多学科大学资源将全力支持农村重建。地方政府也参与研究和探索这种新的可持续的农村重建方式。农村居民被赋予权力，并有机会与农村建设的不同利益相关方合作。结果验证了一种适合于局部重建的方法。在接下来的阶段，这一抗震土建体系将被应用到中国西南地区更多的农村工程中。我们将出版书籍和指南系统地记录这种方法。我们的经验将为地方政府制定重建战略提供依据，为今后国家土建重建政策和抗震标准提供参考。

house. The soil of the site was examined in the lab of Kunming University of Science and Technology and adjusted properly with sand, straw, and small amount of cement to avoid cracks and improve the strength and waterproof performance of the wall. Concrete ring beams are added to the wall to improve structural integrity and to avoid vertical cracking. The concrete belts are hidden in the wall so that the earth facade could be integrated. Aluminum alloy formwork and electric rammer has been used to make the wall substantially compact and smooth.

Instead of promoting the benefits of imported brick and concrete, we determined whether the shortfalls of traditional rammed earth typology and the fragility of village life could be addressed in situ. The reconstruction limitations of Guangming Village included poverty, high transportation cost, lack of skills, lack of confidence in failed construction techniques, poor accessibility, climate particularities and the aspiration of villagers for modern housing that was bigger, better and more stable than their old homes. All these criteria were fully considered and tackled throughout the process. The solution was defined according to the geological and climate conditions in the area. The implementation of this strategy was a simple step to rebuilding the lives of the people. We protected and innovated the local traditional rammed earth construction method. With this simple strategy and the empowerment of the local residents, the performance of the rammed earth buildings was improved, thereby protecting the lifestyle of the village.

Furthermore, we try to protect this kind of construction method and lifestyle because of the vast amount of villages in Yunnan that are facing the choice of maintaining the traditional architecture or applying industrial building materials. A remarkable number of rural earthen architecture are classified as dangerous buildings that need rebuilding. The local government is still looking for a good solution that is low-cost and can improve the safety and comfort of the vernacular architecture without destroying its historical and cultural values. This demonstration project is constructed not only to integrate with the existing surrounding environment but also to integrate with the large context of rural Yunnan by demonstrating an endogenous and sustainable solution.

The team contributes professional knowledge and advanced technology while local residents provide local knowledge and manpower. The project wouldn' t be success if effort from either side is missing. Villagers are respected and fully engaged in the whole reconstruction process, apart from construction works, they also involved in designing their new home. Trust and relationship between our team and the villagers have been established during the construction process. Local lifestyle and construction method was protected and enhanced.

In this project, multidisciplinary university resources are in full support of rural reconstruction. The local government is also involved to examine and explore this new sustainable way of rural reconstruction. Rural residents are empowered and are given a chance to collaborate with different stakeholders of rural constructions. The result verified an appropriated solution of the local reconstruction. In the subsequent stage, this anti-seismic earth building system will be applied to more rural projects in Southwest China. Books and guidelines will be published to systematically document this method. Our experience would provide basis for local government to formulate reconstruction strategies as well as references for national reconstruction policies and seismic standards for buildings made of earth materials in the future.

Basic Situation

After the Ludian earthquake in 2014, most of the local rammed-earth buildings in Guangming Village were destroyed. Villagers chose to build brick–concrete houses during the reconstruction period. However, the price of building materials rapidly increased and became unaffordable for most local villagers.

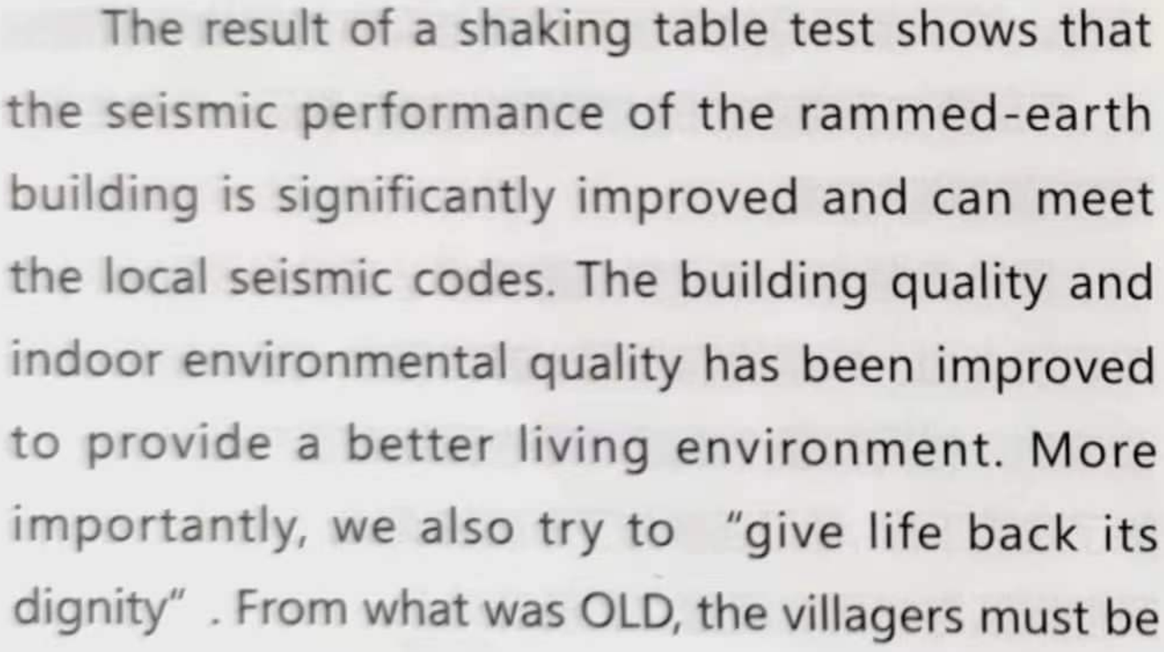
This project innovates the traditional rammed-earth building technology to provide villagers a safe, economical, comfortable, and sustainable reconstruction strategy that the villagers can afford, own, and pass on.

A prototype house has been built for an aged couple to validate the technology and building performance of the innovative rammed-earth building system. The "high-science and low-technology" strategy and "3L" (local technology, local materials, and local labor) principle has been implemented in the reconstruction project.

The result of a shaking table test shows that the seismic performance of the rammed-earth building is significantly improved and can meet the local seismic codes. The building quality and indoor environmental quality has been improved to provide a better living environment. More importantly, we also try to "give life back its dignity". From what was OLD, the villagers must be very proud of the NEW that they are getting.

Helpful Comments from the Project

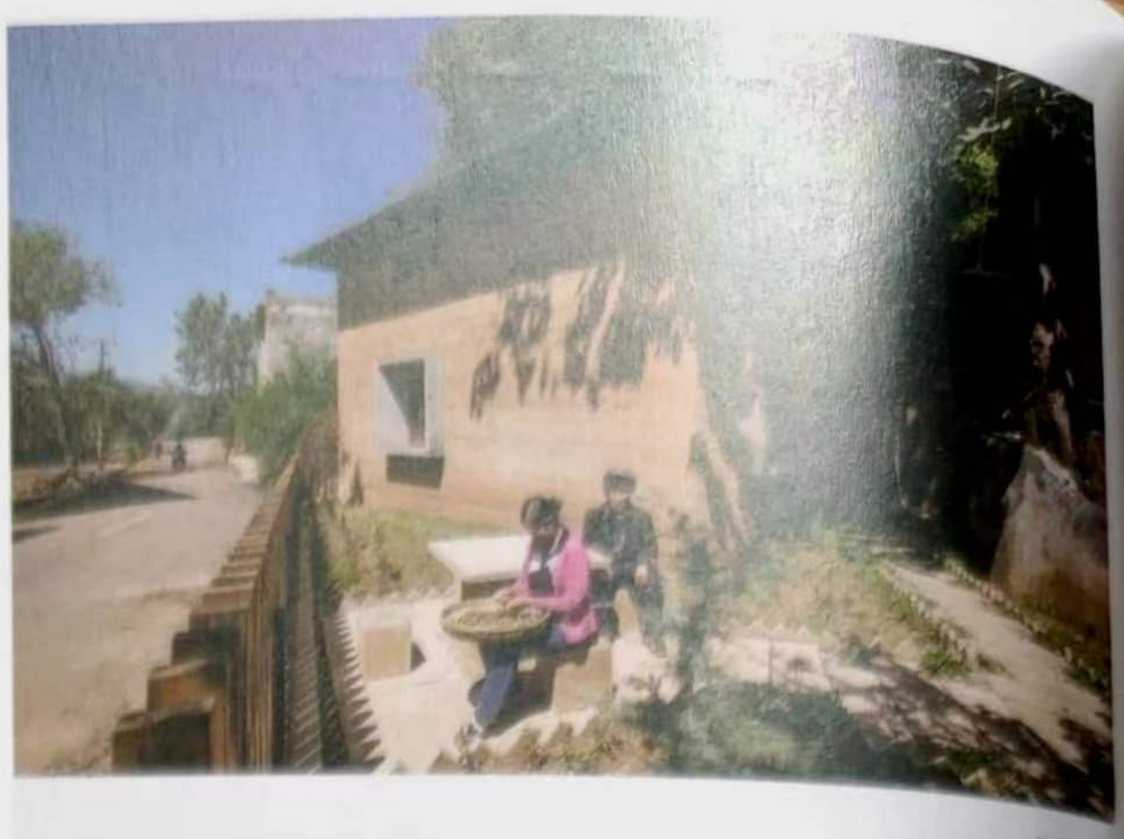
To ensure a systematic and sustainable rural reconstruction work with innovative ideas, scientific



Gound floor plan

First floor plan

The floor plan



Model

research is essential to understand the context, identify the problem, and find a proper solution. To empower the local residents and encourage endogenous development, the proposed innovative technology should be simple and easily disseminated to the local residents. The outside materials and labour should be limited to reduce construction cost and improve the local market. Therefore, the "high-science and low-technology" strategy and "3L" principle was suitable for the local condition of the poor rural areas in southwest China.

The prototype house was built for an aged couple who lived in a tent after the earthquake. A passive design with recycled local materials gathered from the ruins ensured a comfortable indoor environment and low energy consumption. The design was integrated with semi-outdoor spaces to provide a comfortable and artistic living environment for the aged couple. The semi-outdoor atrium with a skylight and cross ventilation was bright and had natural ventilation. Double-glazed windows and insulated roofs were used to improve the thermal performance of the building. A steel roof structure and aluminium alloy windows were used to increase building quality and airtightness.

Several innovation has been done to improve the seismic performance after a survey and study of the weak points of the local traditional rammed earth buildings. Appropriate size of concrete foundation with a correct cement mortar to enhance the integrity of the foundation of the