Maosi Ecological Demonstration School in Gansu Province, China

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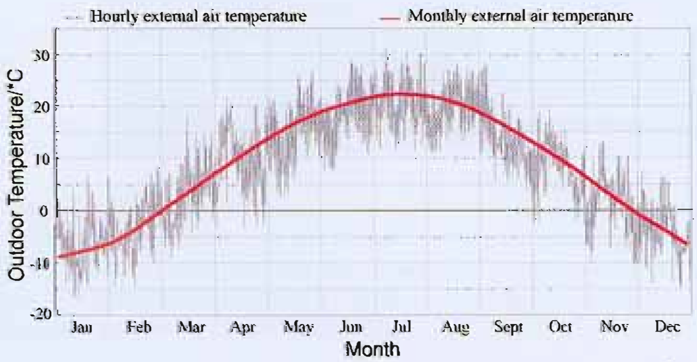

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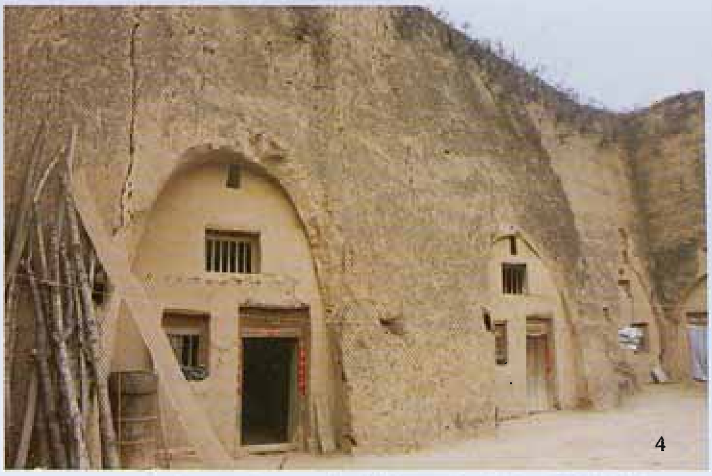
Background

On July 30th, 2006, the villagers of Maosi Village were jubilantly celebrating for the completion of the First and Second Phases of the Maosi Ecological Demonstration Primary School. With funding from Hong Kong donors and support by a team led by Professor Edward Ng, a new primary school was erected after three months of construction. Sir David Akers-Jones, the former Chief Secretary for Administration of Hong Kong, officiated at the Opening Ceremony. Guests included representatives from China's Ministry of Construction, who gave valuable support & assistance. Watching the lovely and joyful children singing and dancing in front of the beautiful new school, Sir David, Prof. Ng, and all involved felt great happiness and pride which is simply beyond words. Their hard works and diligence turned a dream, for generations, to come true.

Maosi village is located in Gansu Province, around the centre of Loess Plateau, which is with the thickest loess deposit of the world, and is one of the poorest parts of China. In 2003, baffled by local limited, shabby education conditions and the shortage of fund, the local government initiated to replace 4 existing sub-standard schools with a larger primary school, which can accommodate 400 pupils. Prof. Ng took the opportunity and led a team to carry out the school project.



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Objectives

The region of the village is characterized by environmental degradation, a lack of resources, and low levels of economy, education and technology. Over the past centuries, pollutions, soil salinization, desertification, water & soil loss and drought affect the villagers' subsistence. During site visits, many new schools and dwellings are found to be inadequate for the local climate. The interiors are too hot in the summer and too cold in the winter. Large single pane windows, thin roofs and wall construction and incorrect site layout are expensive to build, difficult to maintain, and impossible to occupy unless fossil fuels are used to remedy the micro-climate. Indeed, the operation of these buildings would further damage the environment. The objectives are two-fold: to design and build a "demonstration school" for the children of the village and to educate school builders and officials what an environmental-friendly village school should be, i.e. to be in harmony with human, nature and buildings.

Environmental Considerations

A series of investigation and scientific studies were carried out before the actual design. It focused on the local vernacular architecture, such as earth caves and vaulted houses. After more than a thousand years of development and evolution, the traditional architecture has embodied a lot of ecological elements which are worthy to be developed and adopted in the eco-school design. Among them is low embodied energy building materials and the way of construction. Simulation studies with TAS are employed to select effective techniques and predict their thermal performance. It is found that a combination of developed earth-based technology and passive systems can help to achieve an optimal thermal performance with a minimum use of fossil fuel. Moreover, the building cost is directly proportional to its thermal performance. Thermal mass and insulation are the keys to improve the performance of buildings. Passive solar system, depending on its design, may not be cost-effective. With limited resources, the design emphasizes on the use of local natural materials and techniques, conditional utilization of natural energy and the ease of construction.

1. Overview of the construction site of the 1st And 2nd
2. Location of loess plateau and the Xifeng region
3. Hourly and monthly temperatures in Xifeng (1995)
4. Earth architecture hill-side cave
5. Site plan of the campus
6. Southern view of the classroom
7. Northern view of the classroom

Conceptual Design

With a site area of 10,600 sq.m., the new school is located at an open space in the centre of the village. It is surrounded by 20 to 40m-high hills from the northwest to east sides, opening to the south. It consists of three stepped terraces which descend from north to south with a total level difference of 3 metres. 12 classrooms are grouped into 6 units, arranged on two different levels with the longitudinal axis in the east-west direction. It gives a maximum exposure to daylight and prevailing wind across the buildings. The cluster of classrooms create two courtyards, i.e. an internal garden with trees, flowers and stone chairs for the break between classes, and an open playground for the children's outdoor activities. Footpaths and outdoor areas would be covered with trees and pergolas so as to provide a comfortable and pleasing environment.

The floor area of each unit in which two classrooms are juxtaposed is 199 sq.m., each 6×9m classroom can accommodate at least 50 students. The classroom is covered with a traditional single-pitch roof and supported by timber framework. The northern end of the classroom is sunken aiming to have a better thermal barrier against the elements. The envelope is mainly made of natural materials, such as adobe (mud bricks), rubble, pine timber and straw. The 1m-thick wall helps to stabilize the indoor temperature and reduce unwanted heat flow through walls. Because of its poor waterproofing nature, the foundation is laid with rubbles. Meanwhile, straw mud for wall finishing is mixed with some calces, which can strengthen the wall surface to effectively improve its waterproofing performance. Some tiles are half-embedded in the large area of walls as a rain-shade. For classrooms, concrete is used only on the top of the parapet wall to avoid rain water erosion. Besides employing an 8cm-thick layer of polystyrene as insulation, the roof is still made in the traditional way, i.e. rafter-reed-mud-SBS-mud-tile. All timber windows are double-glazed and are properly sealed with airtight strips. In order to maximize internal daylight, some of the window openings are bevelled.

Construction and Materials

The construction of classrooms inherits the local traditional means. The construction team consists of local villagers who often build dwellings themselves. They are familiar with local traditional building techniques and the joint working sessions on site brought insights to the construction details. Traditionally, energy consumption and environmental impact during construction are minimized. Except for the necessary ditcher and bulldozer for nominal site formation, the construction mainly relies on manpower and simple tools, including the timber scaffold, shovel, hoe, trowel, saw, plane, etc. With the exception of polystyrene, glass, pine timber and small quantities of cement, SBS and calces, all building materials are sourced locally, such as earth-based materials, rubble excavated from close-by hills, straw and reed growing from adjoining fields. The mud brick is made of earth dug out for the foundation. Broken bricks are crushed and mixed into straw mud. Though the roof tile is the biggest energy-embodier amongst the palette, it was collected from nearby collapsed old dwellings. Such tile is quite durable and would last another hundred years. The use of recycled tile would eliminate energy that is used for manufacturing and no doubt reduce environmental impacts.

Reflections

The construction cost is close to that of local brick and concrete composite constructions. According to simulation studies, its operation does not need any energy for cooling and heating in most days of a year. For its optimal thermal performance and low running cost, the eco-classroom should provide children with a more comfortable learning environment. The eco-school project demonstrates one sustainable way for future developments under local limited conditions.

Future Plans

In the 1st and 2nd phase, 8 classrooms were just completed. The remaining 4 classrooms and supporting facilities, including offices, dormitories and landscape site work, would be constructed in the coming spring. Two conventional solar passive systems, namely, the sunspace and Trombe wall will be introduced. The performance of the passive systems will be monitored and re-validated with the simulation model. The findings should help local builders to select an appropriate passive solar technique. The eco-school project would not only create a comfortable, desirable study ambience for children, but also demonstrate a feasible way for the locals to reach their maximum environmental sustainability.

Edward Ng
Professor at Department of Architecture, The Chinese University of Hong Kong.

Mu Jun
Mu Jun is majored in Ecological architecture. He is just graduated from CUHK with MPhil degree and is studying for Ph.D degree. The Maosi ecological demonstration school is a key element in his MPhil thesis, "Experimental Studies Thermally of Ecological Building in Loess Plateau Areas of China".


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8. Interior view of the classroom
9. Construction of the rubble-based foundation
10. Construction of the rubble-attached external wall
11. General construction scene
12. Reed laying on the roof
13. Construction of roofing

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