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Inside: **We are 10! Our contribution to Green & what readers think** | **Janine Benyus;** *Biologist, Co-founder of Biomimicry 3.8* | **FuturArc Green Leadership Award 2016;** *projects in Asia that are making a difference* | **Special Supplement;** *all winners of FuturArc Prize and FuturArc Green Leadership Award 2016*

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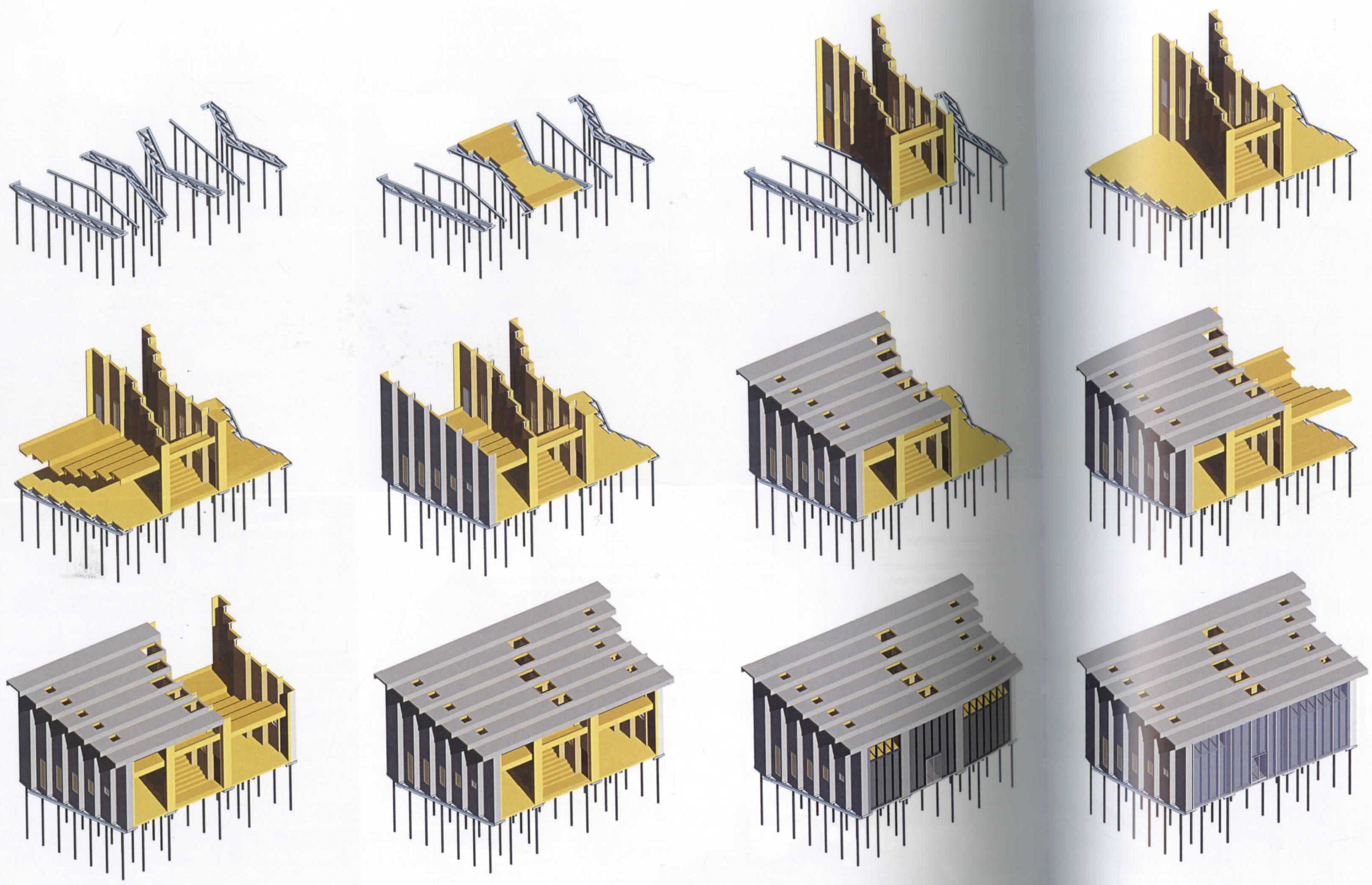

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NEW LAWUGA SCHOOL

PROJECT BACKGROUND AND CHALLENGES

Lawuga Village is a remote village located in a plateau area. The village school, Lawuga School, serves children from the local minority nomadic families. After an earthquake in 2010, two brick buildings that consisted of classrooms were deemed unsafe. This resulted in the children having lessons in the temporary relief panel houses. The New Lawuga School, completed in August 2015, was put into operation soon after that. This building not only serves as a landmark in the village, but also as a showcase that explores a new possibility for buildings in the plateau.

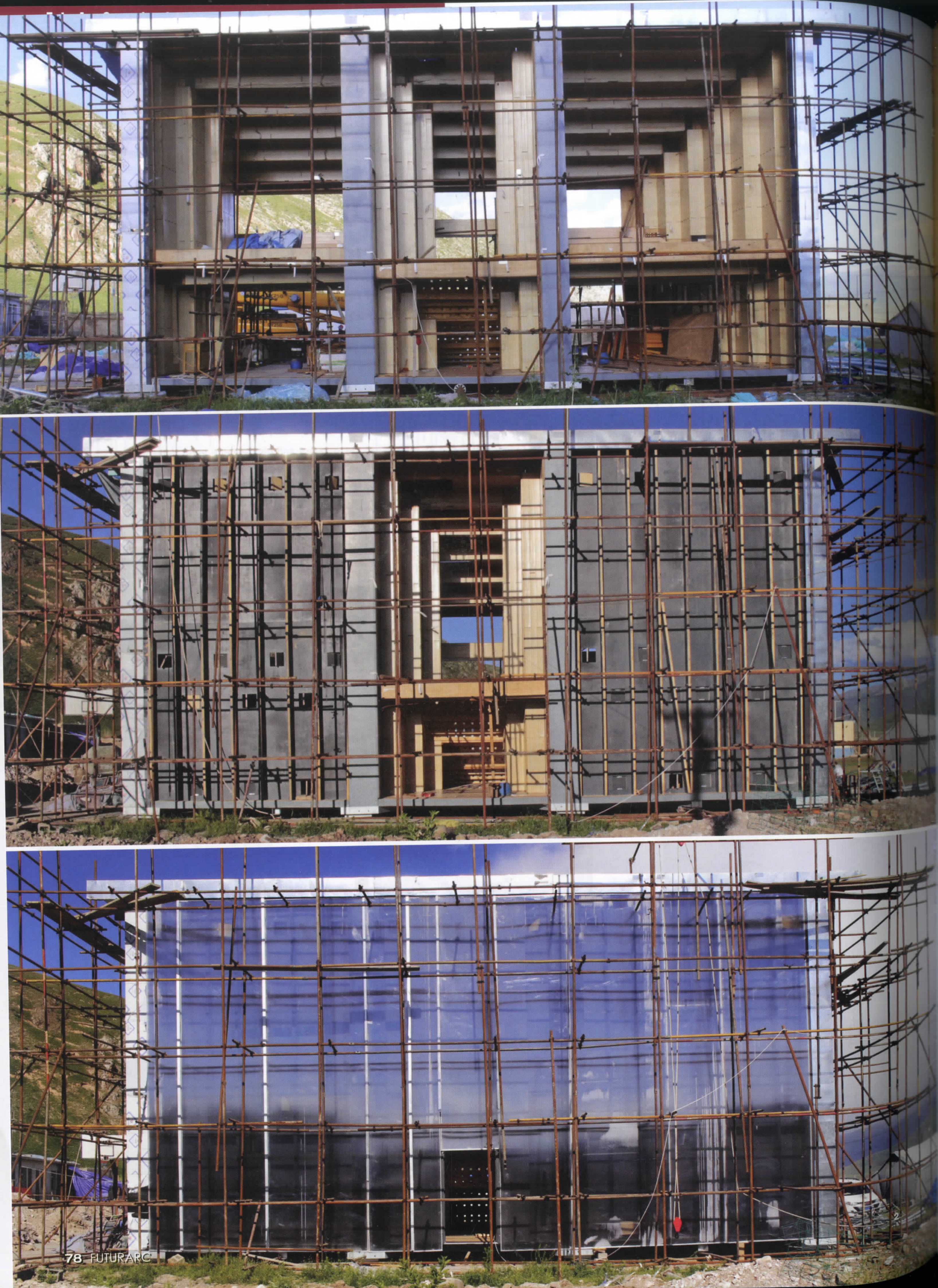
A generous benefactor committed the architect and his research team to design and supervise the construction of the building. Besides providing a safe and warm study environment for the students, the research team took the New Lawuga School as an opportunity to extend the previous experiences and develop a new architectural system that is capable of adapting to the special plateau climate.

Located at an altitude of 3,900 metres above sea level, the site has a typical plateau climate with prolonged freezing winters and rapid temperature changes in the summer. Structurally, the building must meet considerable demands in terms of snow, wind and earthquake. With a fragile ecological system, thin mountain air, and limited construction period from May to September (because of the inclement weather), a rapid ecological construction method was adopted.

This means prefabrication using lightweight components and adopting an integrated construction system. Prefabricating the components would shorten on-site construction period; provide safer site environment for the workers; reduce construction waste; and offer reassembling possibilities, resulting in better and healthier buildings and achieving significant benefits in both environmental and economic aspects.

The architect needed to complete this charity project with limited resources due to a controlled budget. To achieve cost competitiveness, a synthesis system considering materials, structure, insulation, manufacturing, transportation and assembling process was required. The goal was to find a robust and architectural comprehensive solution that would be feasible in terms of production, logistics, insulation and assembly. The fabrication process took place in a city that is 1,000 kilometres away from the site. All building components were transported to the site by trucks. The assembling process was simple and efficient. All panels were either placed or erected. There were a total of 80 panels, and the installation process of the main building structure took only eight days by using crane. A BIM platform was an essential tool in ensuring the completion of the complex project. The detailed 3D model allowed for precise drawings to be generated from the geometrically complicated design for fabrication and construction within a short time. Schedules were produced to monitor the amount of material used even in the early design process. Both of these advantages saved production time and cost for manufacturing. With the clear production drawings, the manufacturing process for the panels only needed a month.

1 Construction diagrams



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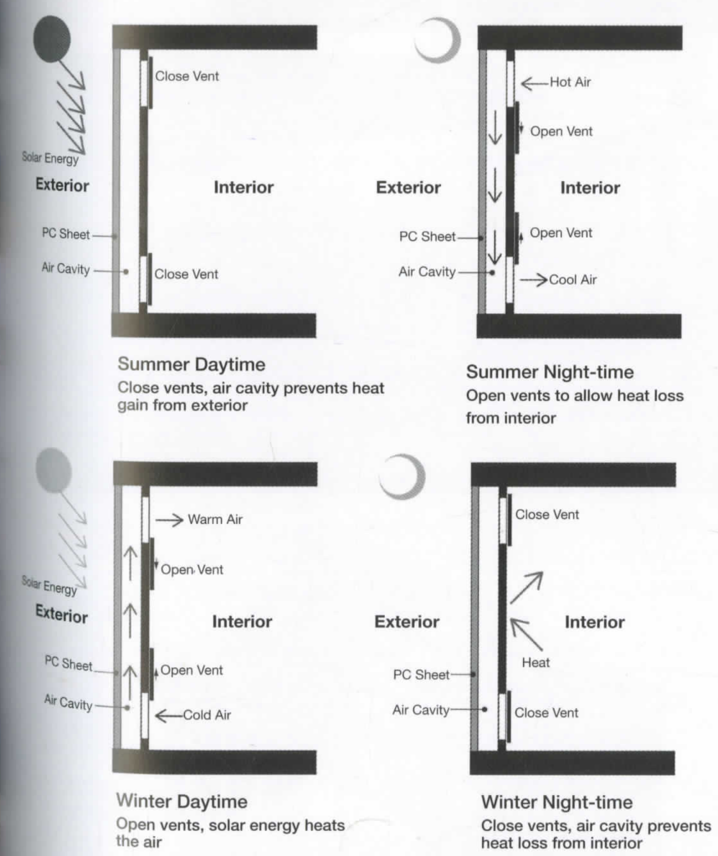

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BUILDING ON A PLATEAU

The school is only half the weight of a same-sized concrete building. Because of its light weight, a ground screw system was introduced for the foundation construction. Galvanised steel ground screw, with a diameter of 110 millimetres and length of 2.8 metres, were pierced into the soil by the powerful driver. The screw pile penetrated through the 1-metre thick permafrost layer. The installation of the ground screw was a reversible process, reducing permanent damage to the subsoil.

For thermal insulation, the school is lifted up from the ground to prevent undesirable emission of heat to the subsoil. All the periphery panels, floor, wall and roof panels have a thick insulation layer of 150 millimetres, ensuring low thermal transfer values. The exterior fenestration is either double-glazed or triple-glazed to ensure thermal isolation. At the east and west elevations, Trombe walls made up of wooden L-shaped framework and polycarbonate sheets were installed. A simple operation could allow the Trombe wall to obtain large quantities of passive solar energy or create air barriers to prevent energy exchange, according to the external environment. The external polycarbonate sheets, depending on the light situation, can appear anything from deep black to dazzlingly bright, reflecting the mountains and sky.

SPATIAL DIFFERENTIATION

The New Lawuga School project applied the Z-panel system (see sidebar for details) to allow complex spaces to be formed within the tidy building. The school comprises two classrooms; two terrace classrooms; one central atrium; one reading space; and one storage space, providing 210 square metres of floor area. The spatial differentiation originated from the space's scale, spatial geometry and orientation, and is further enhanced by the window design, which controls the view and light condition. Yet, all the different spaces are closely dependent on one another, forming loop circulation and providing a rich spatial user experience.

2 Different stages of construction **3** Classroom **4** Sectional diagrams illustrating how the Trombe walls work

Z-Panel System

The Z-panel system was developed by the architects specifically for this project. The two 'wings' at the long edges entrusted the spatial defining panels with different structural possibilities. The Z-shaped panel had high spatial efficiency in stacking for storage. This was important especially in the case of prefabrication when the logistics took up a large portion of the budget. The two 'wings' allowed the panel standing by itself to become a wall by helping to resist the lateral force. If the panel was placed horizontally as floor or ceiling slabs, the wings became beams overcoming the span. When two Z-shaped panels were connected, overlapping the 'wings' was an easy connection that gave strong structural performance and provided excellent airtightness. Panels with C-shaped and L-shaped sections were also developed at a later stage.

The composition of the Z-shaped panel is based on structural insulated panel (SIP), which is a sandwich composite with foam core (e.g., expanded polystyrene [EPS] or extruded polystyrene [XPS]) in-between the sheeting material (plywood, oriented strand board, steel or fibre cement). SIP has an outstanding performance in both thermal insulation and structural stability. In the New Lawuga School, XPS with plywood on two sides make up the central core of the panels. Other layers of gypsum board, waterproofing membrane, and finishing materials such as acoustic panels and metal claddings were incorporated to fulfil the requirements of water/fireproofing and protection, according to the role of the panel in the building.

The thickness, width and length of each panel were an integrated result that responded to multiple disciplines of manufacturing, transportation, construction, thermal performance, and structural and spatial requirements. For example, the periphery wall panels (thickness at 150 millimetres) are thicker than the suspended floor panel (T at 90 millimetres) to withstand the exterior environment; the width of the panels are defined by the raw plywood panel width (1,220 millimetres); the length of all panels were limited by 9 metres for lorry transportation, etc.

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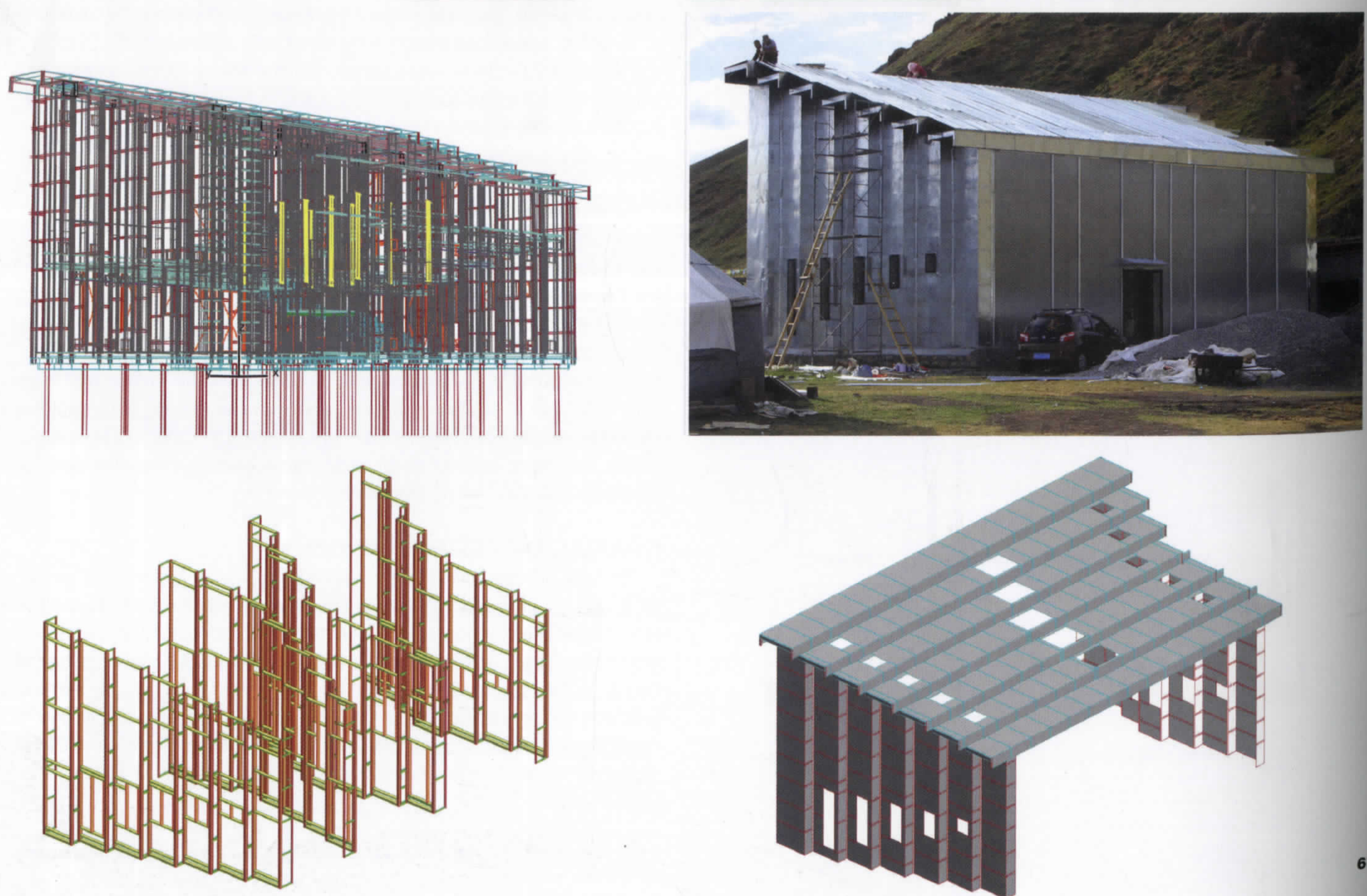

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In contrast to the complicated spatial geometry, the interior finishing uses only two materials: acoustic panel and plank wood flooring, both with a warm wood colour. The plasticity of the surfaces creates a cosy atmosphere for teaching and studying. The façades at the south and north, and the roof of the building are coated with a thin layer of metal cladding. The metal claddings offer robust protection against water, wind and weather. To explore the materiality, two types of metal are applied: galvanised steel is used in the south elevation and the roof, while stainless steel is used at the north elevation. The east and west elevation are large pieces of polycarbonate sheets, with dark wooden channels at the back. Thus, from afar, the school looks like a monolithic object shimmering on the plateau.

NEW BUILDING PROTOTYPE

The new school building brought the local government's attention to input resources for improving the campus, such as the building of a hard-paved playground and new teacher dormitory buildings. It provides a safe and warm learning environment for the rural students and presents a promising future for the new building prototype. – *Edited by Clara Chiang*

PROJECT DATA

Project Name
New Lawuga School

Location
Lawuga Village, Yushu Autonomous Prefecture, Qinghai Province, China

Completion Date
20 August 2015

Site Area
110.382 square metres

Gross Floor Area
210.382 square metres

Number of Rooms
5

Building Height
8.5 metres

Client/Owner
Chen Bixia

Architecture Firm
Architecture Integrity and Innovation Association, The Chinese University of Hong Kong

Principal Architect
Zhu Jingxiang

Mechanical & Electrical Engineer
Qinghai Changsheng Construction Limited

Civil & Structural Engineer
Qinghai Changsheng Construction Limited

Images/Photos
Lau Hing Ching; Architecture Integrity and Innovation Association, The Chinese University of Hong Kong

5 Z-panel system models **6** BIM application
7 The metal claddings offer robust protection against water, wind and weather