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Protective Shelter for the Archaeological Site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018

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Abstract: The protective shelter designed for the Peking Man Cave at Zhoukoudian addresses one of the most radical conditions faced by contemporary architecture: intervention within an active archaeological site of outstanding scientific value, where the architectural design cannot assert autonomy and must instead operate at the threshold between protection and accessibility. Recognised as a UNESCO World Heritage Site, the cave preserves stratified evidence of human evolution spanning hundreds of thousands of years, requiring both strict conservation measures and the possibility of continued research and public interpretation. The project responds to this challenge through a semi-enclosed, reversible architectural system conceived according to principles of minimal intervention and passive environmental control. By suspending a large-span protective structure above the cave without touching the archaeological ground, the design stabilises climatic conditions while preserving the site's physical and perceptual integrity. At the same time, the shelter functions as a spatial device that organises access, circulation and interpretation, enabling visitors to experience the site without compromising its authenticity. Rather than dissolving the tension between permanence and use, the project deliberately operates within it. Architecture here is neither an object nor a representation, but an infrastructural framework that simultaneously guarantees the long-term preservation of a fragile heritage and its transmission as scientific knowledge. The Zhoukoudian intervention thus exemplifies a theoretical position in which architecture is understood as a mediating practice, negotiating between temporal depth, environmental responsibility and cognitive accessibility.

Keywords: *Archaeological heritage, Architectural conservation, Minimal intervention, Reversibility, Passive environmental design*

The archaeological site of the Peking Man Cave is one of the most important of its kind in Asia and has been acknowledged by the World Heritage List of UNESCO since 1987. It consists of a deep natural cave located on the North side of a limestone mountain foothill, discovered and studied by archaeologists during the 1920s and 1930s. Within the cave were found remains of hominids and humans, animal fossils and

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tools dating from the Middle Pleistocene to the more recent Palaeolithic period. As indicated by the World Heritage Centre of UNESCO, "it has led to the discovery of the remains of Sinanthropus Pekinensis, who lived in the Middle Pleistocene, along with various objects, and remains of Homo sapiens sapiens dating as far back as 18,000-11,000 B.C. The site is not only an exceptional reminder of the prehistorical human societies of the Asian continent, but also illustrates the process of evolution." In the several stratigraphic layers of the cave were found remains of Homo erectus (700,000-200,000 years ago), of archaic Homo sapiens (200,000-100,000 years ago) and of Homo sapiens sapiens (30,000-10,000 years ago), together with thousands of tools, ash deposits and burnt bones that testify to the use of fire by Homo pekinensis.

Since the 1990s, a comprehensive conservation plan for the Zhoukoudian site has been elaborated by the National Administration of Cultural Heritage, which listed it as a Key Protected Cultural Heritage Site of National Significance. The Beijing Municipal Government promulgated the Regulations for the Conservation of the Peking Man Site at Zhoukoudian in 1989, later revised in 2009, effectively preventing planned urban expansion as well as mining and industrial activities in its surroundings.

In July 2012, a heavy rainstorm caused the collapse of debris from the cave walls – already uncovered of their natural roofing – onto the bottom ground. While this event led to the accumulation of soil and debris, it also resulted in the discovery of further layers of archaeological interest, making evident the extreme urgency of a protective and conservation-oriented intervention.

The conservation plan had to be drawn and implemented within a relatively short timeframe. During 2013, the client, the Zhoukoudian Museum (a state-owned institution), after receiving approval from the National Administration of Cultural Heritage and technical recommendations from the World Heritage Centre and ICCROM, commissioned the Cultural Heritage Conservation Centre (CHCC) of Tsinghua University Architecture and Design Institute to define the project targets and design goals. The project was undertaken and managed by state-owned bodies and entrusted to an institutional design office with long-standing expertise in heritage conservation and established connections with UNESCO advisory bodies. This framework proved decisive for the project's outcome, particularly in ensuring a continuous and effective dialogue between national

institutions, international organisations and the design team. The final construction drawings were completed in November 2014; construction began in May 2015 and was completed in August 2018. The Peking Man Cave site reopened to the public in September 2018.

The design brief was elaborated and formalised in 2013. Although the architect was involved as an advisor in its definition, the project was required to strictly comply with the brief's requirements. This condition did not exclude architectural discussion; rather, it significantly constrained the range of admissible solutions. In the specific context of an active archaeological site of outstanding scientific value, this reduction of options ultimately became a strength, directing the project toward clarity of intent and coherence of outcome – an assessment that could only be fully verified after completion.

The project targets, as outlined in the design report, can be grouped into two main thematic areas. The first concerns an ecological and environmental conservation strategy, addressing the protection of the archaeological site from climatic agents and the insertion of a contemporary architectural structure within an entirely natural landscape, while respecting and enhancing the mountain's morphology and vegetation. The second area focuses on the conservation, valorisation and transmission of the site's exceptional cultural and scientific heritage, including the provision of appropriate spaces for ongoing archaeological research, public access and interpretation.

With regard to the first group of targets, the brief required the construction of a protective shelter capable of shielding the cave from rainwater, wind, snow and ice – agents that had progressively compromised the site's stability over centuries and posed an immediate risk of further collapse. In addition, the adoption of environmentally passive design strategies was explicitly recommended to mitigate the extreme seasonal temperature variations typical of the Beijing region. The brief therefore indicated a semi-closed architectural solution capable of moderating internal climatic conditions while maintaining visual and environmental continuity with the surrounding landscape.[2]

The proposed design responded to these requirements. The protective structure takes the form of a large roofing curtain drawn over the mountain flank, effectively capping the open-air cave while merging with

2. Icomos 1990.

the site's morphology. To avoid any interference with the archaeological ground, the structure is anchored beyond the cave's northern edge – on the relatively flat foothill terrain – and on the mountain ridge to the South, beyond the cave's upper limit. Spanning approximately 80 metres with a height difference of 37 metres, the roof functions as a large arched vault, stretched over the cavity and subtly bent to adapt to the mountain profile without touching it.

The overall covered area measures approximately 3,847 square metres. From the outset, the designer deliberately reduced the shelter to the minimum necessary extent, in accordance with the conservation principles of minimal intervention and reversibility.[3] The structure consists of an irregular squared grid of tubular steel elements with variable sections, whose longitudinal beams form the main load-bearing arches. The non-linear large-span system was carefully engineered to allow for potential dismantling in the future, thus preserving the integrity and authenticity of the site.

Once the structural framework was defined, the roofing system was developed as a double-skin, semi-enclosed envelope. The external aluminium panels – referred to as "leaves"– are individually inclined to ensure complete rainwater discharge toward peripheral gutters, while maintaining controlled gaps between adjacent elements. These gaps allow filtered daylight and natural ventilation, reducing humidity and temperature fluctuations through entirely passive means and achieving low energy consumption.[3]

On the inner side of the envelope, the aluminium leaves are replicated beneath the steel structure using glass-reinforced panels with a limestone texture. The surface pattern was derived from 3D scans of the cave walls, producing an immersive spatial continuity between the natural cavity and the artificial covering. On the exterior, the decision to allow self-growing and climbing vegetation to colonise the roof enables the structure to gradually blend into the green mountain landscape. Seen from a distance, the vegetated shell evokes the image of a Chinese dragon – an allusion reinforced by the site's traditional name, Longgushan (Dragon Bone Mountain).

Beside environmental protection, the second group of project targets addressed the public experience of the site and the communication of its

3. Hill 2012.

scientific value. The design therefore provides dedicated spaces for archaeological research, interpretation and controlled public access. The main entrance is located on the northern side, marked by a lightweight aluminium canopy distinct from the primary structural supports. Visitors descend via a sequence of steps to the covered area and circulate along elevated wooden boardwalks, ensuring unobstructed views of the cave while avoiding any contact with the archaeological ground. Observation platforms positioned at strategic points offer multiple perspectives of the site, while non-invasive display techniques – such as projected images and multimedia installations – support interpretation without altering the physical fabric of the cave.[4]

In addressing the imperative of heritage conservation, the project adopts a series of architectural strategies that deliberately avoid stylistic emphasis. Rather than asserting a contemporary formal language, the intervention seeks to fade into its surroundings, responding to the genius loci of the site – identified in the cave's primitive character and its exceptional scientific significance as evidence of early human life. By applying conservation principles from the earliest stages of design, the project achieves a condition in which the artificial shelter appears not as an added object, but as an almost inevitable solution.

In 2019, the project received the Golden Prize of the ARCASIA Awards for Architecture in the category of Conservation Projects. As noted by the jury, "Architecture, art, archaeology and sophisticated technology come together in this unusual design which nurtures and becomes one with the terrain and the green around it, while strictly keeping its promise to function. This semi-enclosed, single-spanned and double-skinned structure carefully protects the precious and fragile world heritage site in its natural condition, by protecting it from rain while allowing air and indirect light. Keeping the concept of minimum interference and reversibility, the structure is designed to merge seamlessly with the surroundings over time".

4. Icomos 2005.

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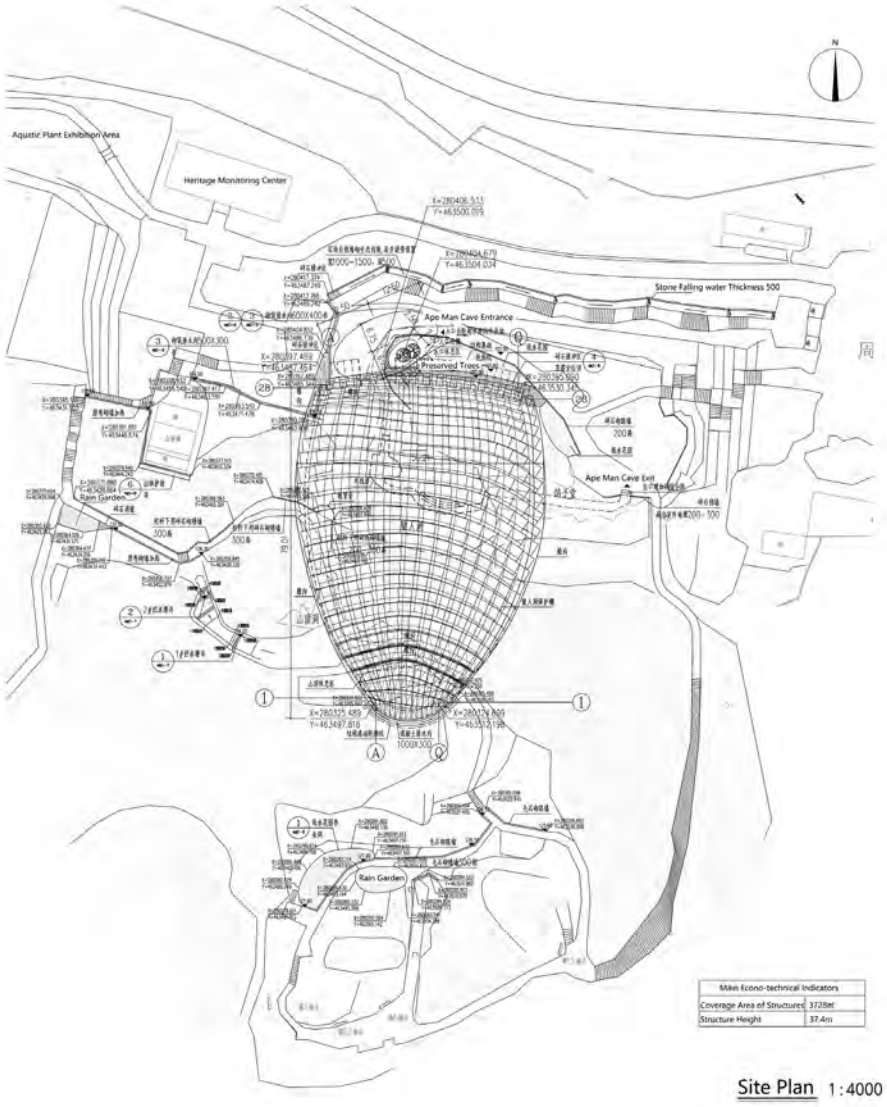
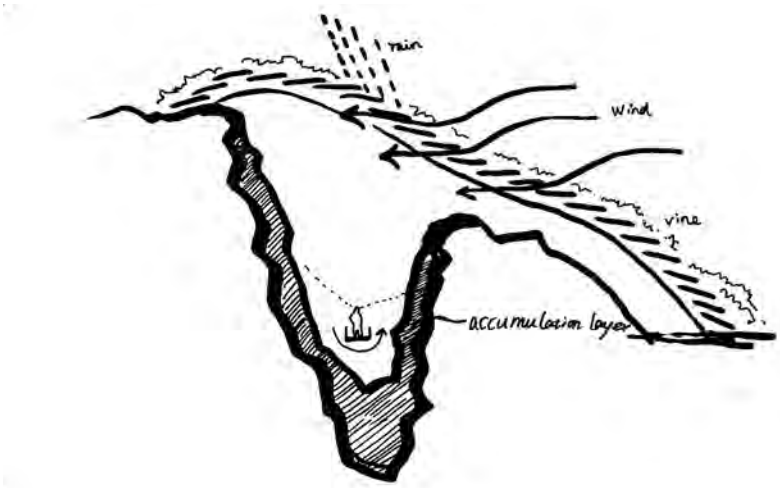
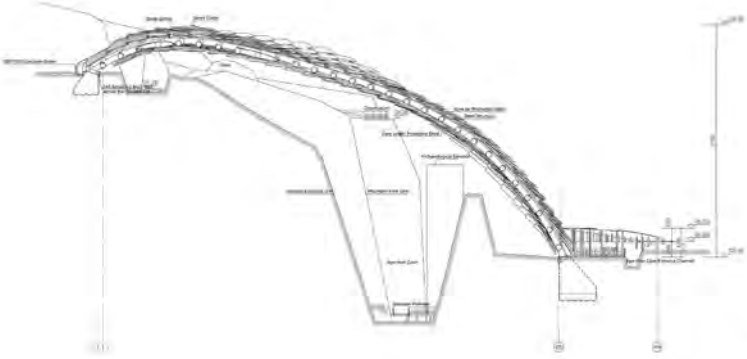
Fig. 1. Overview from East, Fig. 2. Exterior view from East, Fig. 3. Overview from West.

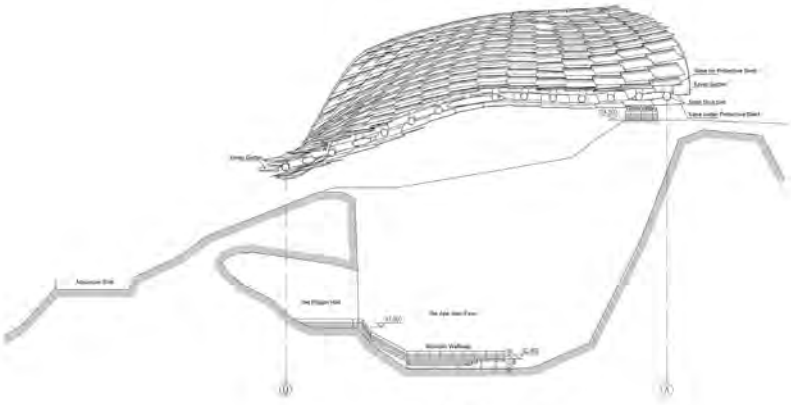


Protective Shelter for the archaeological site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018.
Fig. 4-7. Site Plan, Concept sketch, Section South-North, Section East-West.

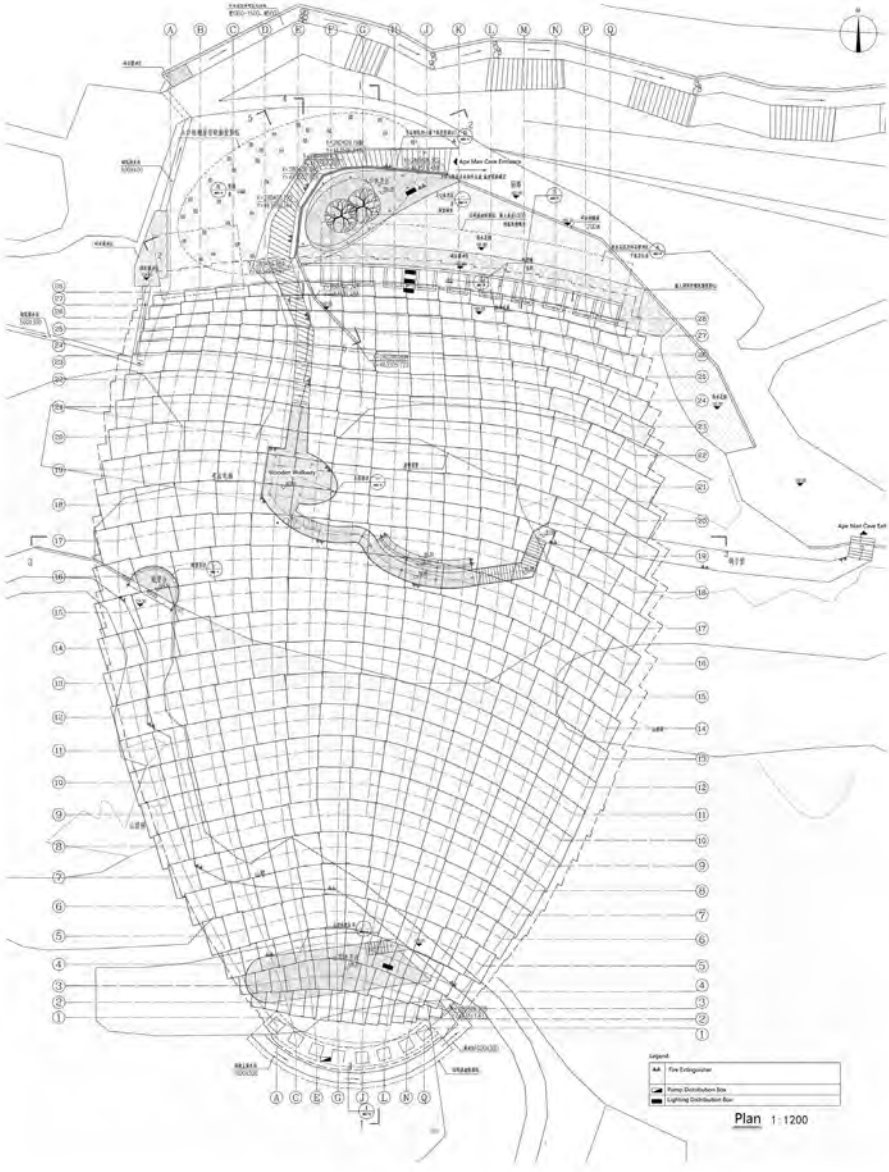




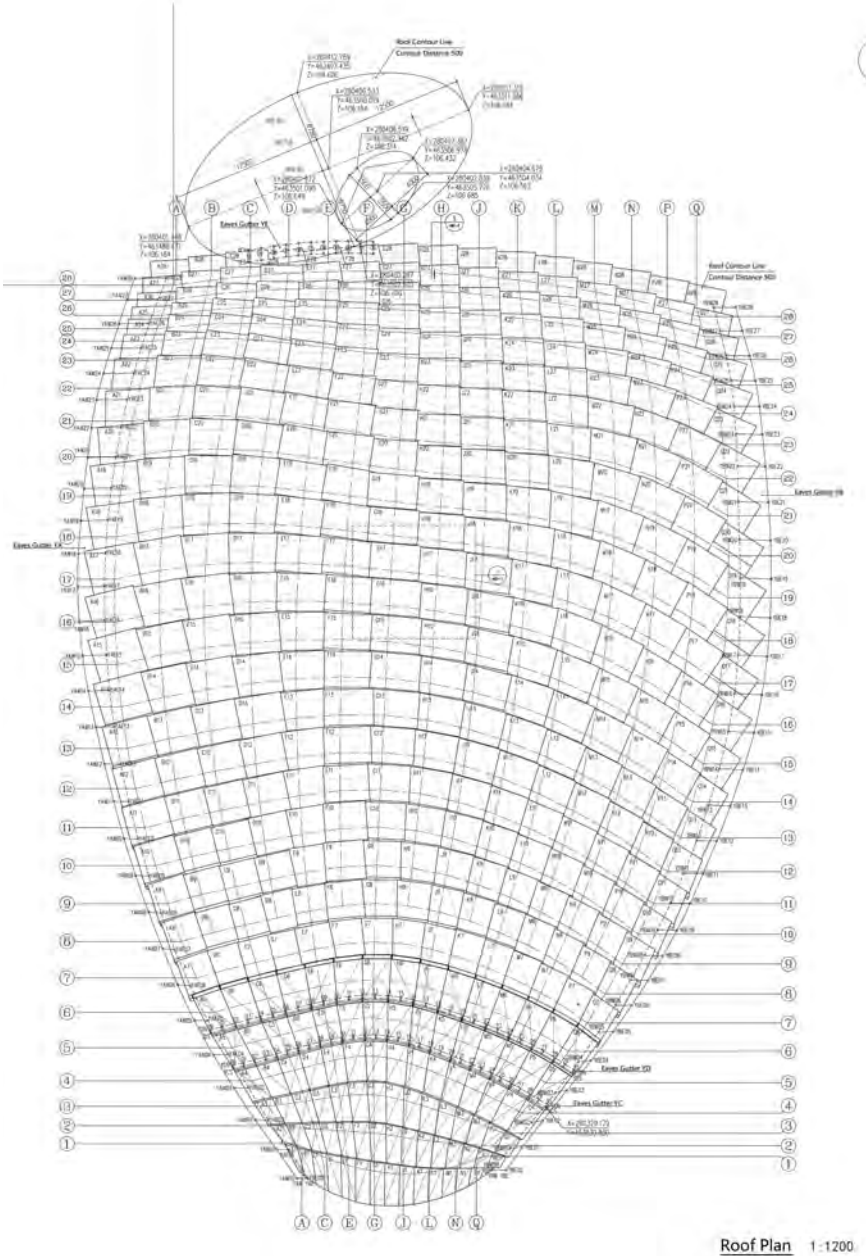
1-1 Section



3-3 Section 1: 1600



Protective Shelter for the archaeological site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018.
Fig. 8-9. General Plan, Roof plan.


Roof Plan 1:1200

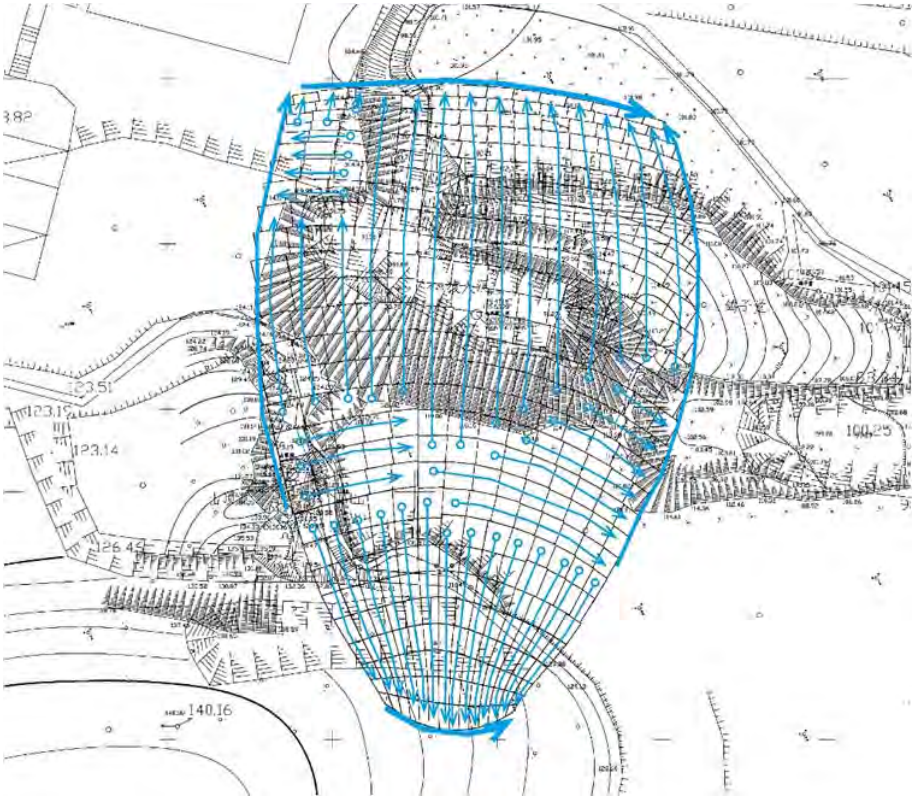


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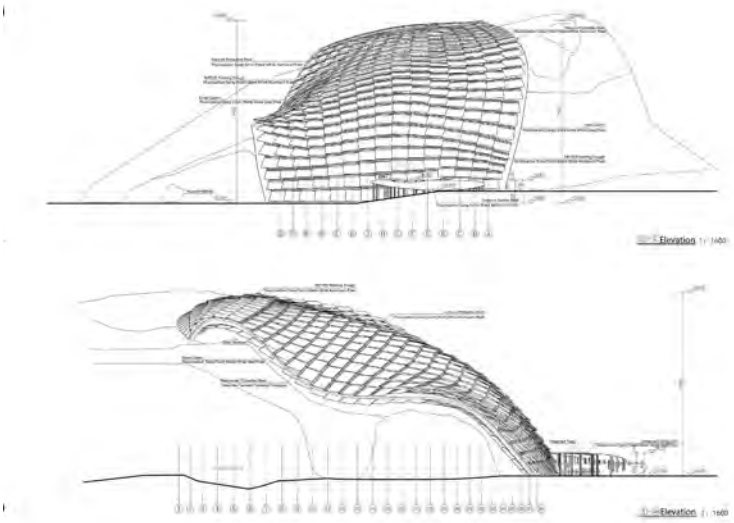
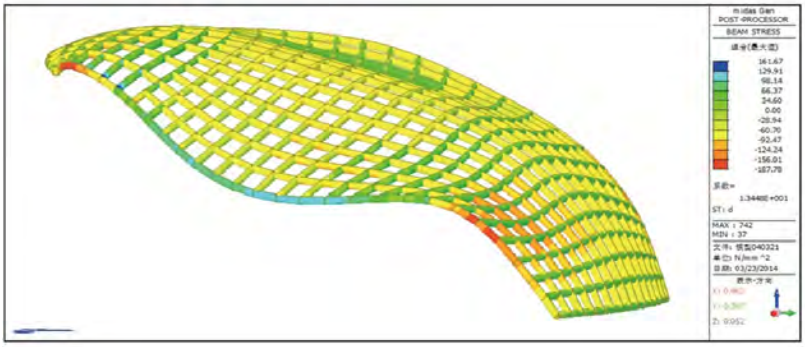
Fig. 10-12. Elevations, Structure Study, Steel Structure in Construction.

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Protective Shelter for the archaeological site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018. Fig. 13-17. Winter Overview from North, Inner leaves from top entrance, Inner leaves at top level entrance, Site overview with landscape.

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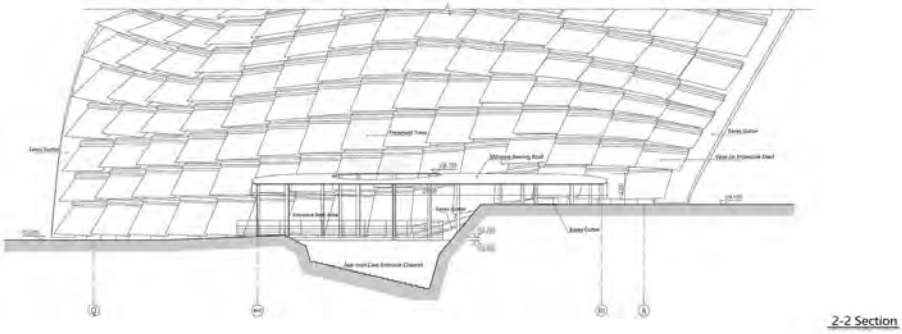
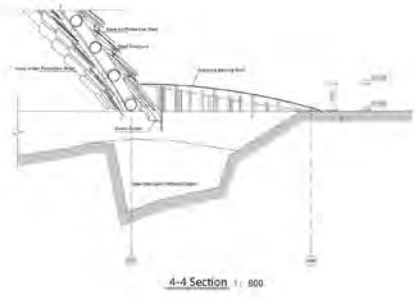
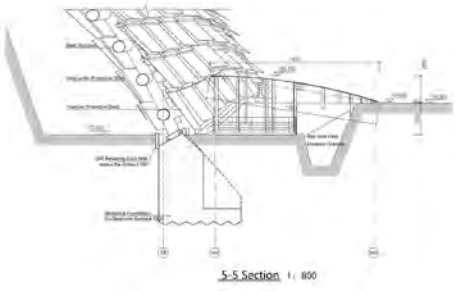
Fig. 18-20. Exterior leaves. Exterior leaves side view and detail views.

Protective Shelter for the archaeological site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018. Fig. 21-25. Exterior leaves at foothold, Exterior leaves in construction, Exterior leaves detail, Intermediate level plan, Sections.


115m Elevation Plan 1:1250


2-2 Section


4-4 Section 1 : 800


5-5 Section 1 : 800

Protective Shelther for the archaeological site of Peking Man Cave, Zhoukoudian, Beijing. 2013-2018. Fig. 26-29. Cave ceiling-at top, Entire ceiling-from bottom, Cave ground-towards East, Cave ground-coloured lights effect

Thousand Buddha Cliff of Guangyuan, Sichuan. 2011-2022.
Overview from North, with completed Test Section in the foreground.