

A Review on the Post-Earthquake Emergency Conservation Project of Fulong Taoist Temple

Yuhua Zhu*, Bowen Li

Beijing University of Civil Engineering and Architecture, Beijing 100044, China

*Corresponding author: Yuhua Zhu, Zhuyuhua@bucea.edu.cn

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Abstract: The 2008 Wenchuan earthquake in Sichuan Province caused significant damage to Dujiangyan irrigation system, which is one of the world's cultural heritages. After the earthquake, the Chinese government launched the post-earthquake emergency conservation project for cultural heritages. The Fulong Taoist Temple in Dujiangyan was the first to adopt the conservation project. The earthquake-damaged Fulong Taoist Temple was restored in just 18 months. This article reviews the entire emergency conservation project of Fulong Taoist Temple in Dujiangyan after the earthquake, discusses the restoration principles and technical methods used in this project, and uses the comments of the Asia-Pacific Heritage Protection Award to expound the historical significance of this protection project.

Keywords: Post-earthquake emergency; Heritage conservation project; Fulong Taoist Temple

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1. Introduction of the project

The post-earthquake emergency conservation project of Fulong Taoist Temple is one of the most important cultural heritage conservation projects implemented in China in 2009 (**Table 1**). The project started in June 2008 and lasted for 18 months. It was the first cultural heritage conservation project to be carried out in the disaster-hit area after the earthquake on May 12, 2008, and also the first project of its kind to be completed.

Table 1. Details of the post-earthquake emergency conservation project of Fulong Taoist Temple

Location	Dujiangyan City, Sichuan Province, China
Site area	3000 m ² , with a floor area of 1900 m ²
Conservation design	Cultural Heritage Conservation Centre, Beijing Tsinghua Urban Planning and Design Institute
Date of completion	December 2009

Under the background of Sichuan's great reconstruction after the earthquake, the project has attracted attention from the public across the country. Experts in the field of cultural heritage conservation, in particular, consider these serious post-earthquake emergency restoration projects in Sichuan as practical examples of efficient responses to sudden catastrophes. The conservation project of Fulong Taoist Temple is undoubtedly one of the best practices (**Figure 1** and **Figure 2**).



Figure 1. Northeast view of Fulong Taoist Temple



Figure 2. Northwest view of Fulong Taoist Temple

There are four objectives in this conservation project. The first is to resume the integrity of Fulong Taoist Temple based on careful site investigation, damage recording, and the maintenance of authentic materials. The second is to enhance the structural stability and safety of the temple. The third is to maintain the characteristic local historical buildings by adopting their traditional techniques and materials. The fourth is to revive local cultural tourism and rebuild the daily life and confidence of the local community.

There are five main conservation works in this project. The first involves the removal of potential dangers and risks at the site. The second involves the collection and storage of original building components. The third involves site investigation and damage evaluation, followed by conservation plan design. The final involves the implementation of the project and on-site supervisory control.

The project started in June 2008 and ended in December 2009, which lasted 18 months. From the historical progress of the project, it can be divided into several stages.

- (1) On May 12, 2008, the earthquake took place in Sichuan Province, China.
- (2) In early June 2008, the conservators from Cultural Heritage Conservation Center conducted their first site investigation, recorded the damage, and completed the site investigation report.
- (3) In late June 2008, they completed the post-earthquake emergency rescue work and conservation design plan of Fulong Taoist Temple.
- (4) June 30, 2008, marks the start of the Fulong Taoist Temple conservation project.
- (5) In February 2009, the foundation reinforcement of Fulong Taoist Temple was completed.
- (6) In May 2009, the consolidation of the timber structures of Laowang Hall and Tiefu Hall was completed.
- (7) In October 2009, the reconstruction of Yuhuang Hall was completed.
- (8) On December 26, 2009, the entire project was completed.

2. History and present buildings of Fulong Taoist Temple

Fulong Taoist Temple is located at Li Dui Hill, the foot of Bao Ping Kou (an irrigation channel shaped like a bottle), which is one of the ancestral temples in commemoration of Li Bing and also part of the Dujiangyan irrigation system in Sichuan Province (**Figure 3**).

According to legend, Li Bing, the local governor during the Qin Dynasty, defeated the wicked dragon, and excavated the hills here, inducting river water into the lands of Chengdu Plain, making the plain a wealthy region for thousands of years. As early as Northern Song Dynasty (13th to 14th century), Fulong Taoist Temple had been developed and reserved for the commemoration of Li Bing. Its name has remained unchanged ever since. The temple has been conserved and restored in each succeeding dynasty before reaching its current state.

At present, Fulong Taoist Temple covers an area of 3,000 square meters, with a floor area of 1,900 square meters. The building can be divided into three parts, each of which is dominated by Laowang Hall, Tiefo Hall, and Yuhuang Hall, respectively. The whole complex is built from timber structures that rise in arrays along the longitudinal axis of the terrain and are connected by the overlaid corridors. Outside of the courtyard, Wangjiang Pavilion is situated in front of the temple, while Huaigu Pavilion is situated behind it. The temple, of which three sides are built on the steep cliffs of Li Dui Hill, is set on the bank of Min Jiang River. With its unique location and environment, the temple looks especially majestic and serene, naturally and harmoniously blending into the environment (Figure 4).



Figure 3. Dujiangyan City in China

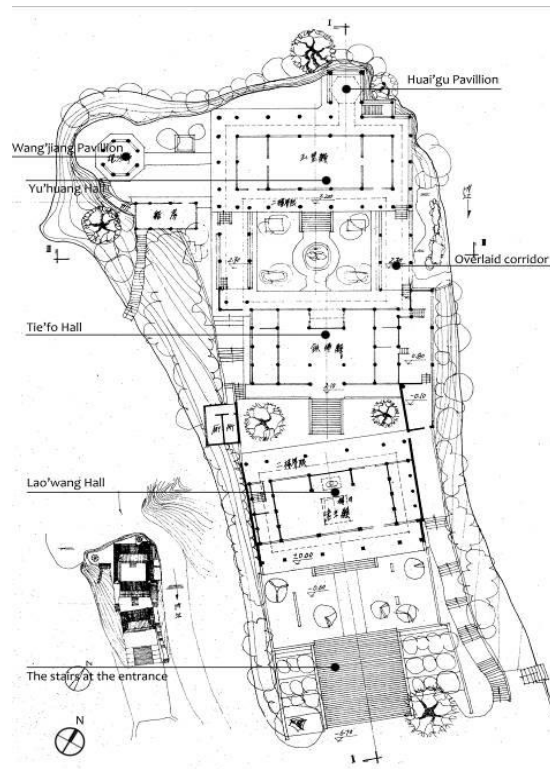


Figure 4. Site plan and 1st floor plan

Laowang Hall covers an area of 386 square meters, having hip and gable roofs with double eaves. The precious statue of Li Bing is laid inside. Tiefo Hall has a double-pitched roof and covers an area of 304 square meters. Yuhuang Hall, on the other hand, reflects a modern architecture built in masonry structure in 1959, with its external appearance imitating a traditional timber building. The newly constructed Yuhuang Hall and the corridors have caused some negative impact on the historical environment and structure; especially, the connection of the two side corridors inserted into the roof structure of Tiefo Hall has damaged the original timber structure used during the Qin Dynasty.

3. Articulation of heritage values and significance

Fulong Taoist Temple is one of the most famous ancestral temples in commemoration of Li Bing for the Dujiangyan irrigation system. With its unique geographical location, its well-conserved building complex, and its integrated landscape between manmade works and natural environment, the temple reveals its significance in historical, aesthetic, and scientific values.

- (1) Fulong Taoist Temple is part of the world's heritage history and culture of Dujiangyan irrigation system, having exceptional historical significance.

- (2) Since the Han Dynasty, the old edifices of Fulong Taoist Temple have served as a memorial to Li Bing. Most of the existing buildings were built during the Qing Dynasty, carrying abundant historical value.
- (3) Fulong Taoist Temple embodies a typical wooden-structured style of southern regions in China, embodying distinct decoration features of western Sichuan, thereby having scientific value for further research.
- (4) The interior and exterior courtyards of Fulong Taoist Temple are excellent examples of gardening art, where patios are paved with stone pavements and decorated by the greeneries, reflecting the traditional gardening concepts of Chinese ancestral temples. It is also an important standpoint to admire the Dujiangyan irrigation system that has fairly high aesthetic value and research value.
- (5) Fulong Taoist Temple is also a well-known tourist destination in Dujiangyan, where tourists can learn about the city and appreciate the hydraulic project. The site also provides a great opportunity for local employments. In this way, it demonstrates the realistic value for social education and cultural propagation.

The ancient buildings of Fulong Taoist Temple that were under conservation included Laowang Hall, Tiefu Hall, Yuhuang Hall, the eastern and western overlaid corridors, Huaigu Pavilion, and Guanlan Pavilion. The goal of the conservation project was to reduce the negative impact caused by the earthquake, repair the damage to these historical buildings, and resume the integrity of the building. The main restoration works took place in several aspects.

- (1) Part of the eastern corridor structure inserted into the roof of Tiefu Hall, which damaged the integrity and stability of the original timber structure, caused significant damage to Tiefu Hall during the earthquake. In this conservation project, the eastern corridor structure was restored according to its disassembled components, the historical information left on the joints of other wooden members, and the timber structure of the western side of the corridor. After the restoration, the eastern timber system regained its structural wholeness, thus guaranteeing the safety of the building.
- (2) Laowang Hall used to be an exhibition room for the public, and the separations of each end were adapted to storage rooms of two stories high. Before the earthquake, it was dangerous to use the temporary staircases to go up and down. Through this restoration, the wooden staircases were rebuilt following the traditional technique. This solution does not add any more load on the original structure, but rather coheres with the original timber structure.

4. Methodology and principles of restoration

Based on the investigation report, Laowang Hall and Tiefu Hall are both historical buildings of the Qing Dynasty, whereas the other buildings were reconstructed or refurbished in modern times. The objectives of this conservation project were not at all complicated, but the issue lies in the aim of this restoration project. The aim of this project is to resume the integrity Fulong Taoist Temple in a rapid speed. Besides, the conservation project should not only meet the principles of authenticity, but also gain emotional recognition from the local community.

This conservation sought to simultaneously recover the authenticity and integrity of the structure of Fulong Taoist Temple in a rapid manner based on careful site investigation and the thorough understanding of restoration principles. Therefore, a few basic restoration principles were set while designing the project (**Figure 5**).

- (1) Principle of authenticity
 - (a) Preserve the physical carrier of historical information (**Figure 6**)
 - (b) Retain the authenticity in the cultural and emotional values of Fulong Taoist Temple

(2) Principle of preserving the original form of heritage

(a) Preserve the original architectural space and building form based on the site plan before the earthquake (**Figure 7**)

(b) Do not add or eliminate any construction parts

(3) Principle of maintaining the historical environment

All the geological or foundation consolidations should not alter the historical environment, including the site landscape, the pavement of the yard, and the plantings (**Figure 8**)



Figure 5. Front view of Fulong Taoist Temple after the earthquake



Figure 6. Interior of the first floor of Laowang Hall after the earthquake



Figure 7. Cracks seen on the brick column of Yuhuang Hall after the earthquake



Figure 8. Front yard of Tiefo Hall after the earthquake

Practically, the conservation should not only meet the principles of authenticity, but also gain emotional recognition from the local community and meet the needs of tourism in the future. The restoration project emphasized on several points.

(1) An organization system with high efficiency

The professional conservation institutes and conservators made their first on-site investigation as soon as the disaster took place, and they then established the conservation principles. Not only the construction company but also the design institute visited the site right after.

(2) The use of traditional materials and techniques

Special attention was paid to the historical information found during the conservation. Therefore, the project was technically accorded with the national requirements on historic building conservation.

(3) A project based on the site plan before the earthquake

The style and features of the buildings remained the same as those before the earthquake. This is thought to be a useful tool to retain the emotional link of the local community.

5. Technical issues in the conservation project

5.1. Adoption of traditional maintenance techniques

The most common problems in using wood include corrosion, termites, splitting, cracking, disconnection of joints, inclination, loss of components, weathering, and fading of colors. Different traditional techniques were used based on the degree of damage in terms of its level and position. However, the general principle was to retain the original members and structures on the premise of ensuring the rationality of the structures and the load-bearing capacity (**Table 2**).

Table 2. Traditional conservation techniques

Types of decay	Level or position of damage	Maintenance
Rot decay and termite-biting of columns	Damage less than 1/3 of the column height	Replacement of the decayed column (partial)
	Damage more than 1/3 of the column height	Replacement of the whole column
Decay and termite-biting of other components	Slight	Partial mending and replacement (reinforced with iron hoops)
	Severe but not occurring at the site bearing the main load	Replacement in local areas
	Severe or at the site bearing the main load	Replacement of the whole component
Splitting and cracking of wood members	Slight	Patching
	Severe or too extensive	Replace with a new one
Pulling out of tenons and inclination	Slight or severe	Force back to their old positions
Loss of components	Entire	Complement based on their original forms
	Partial	Partial repair or complementing
Weathering and color fading	Slight	Retain the original form
	Severe	Color enhancement
Insect-preventive and antiseptic treatment	New members	Soak in medicinal solvent
	Original members	Coat with medicinal solvent

5.2. Different treatments for different buildings

In the conservation, different treatments were used based on the severity of the damage (**Table 3**).

Table 3. Conservation treatments for different buildings

	Traditional maintenance methods	Restoration to the original form or appropriate adjustment	Retaining historical information clues
Laowang Hall	Timber structure, interior wooden decorations, walls, floors, decorative plaster moldings, color painting, and oil painting	Stairs (four-flight stairs to two-flight stairs)	The outer room wall with murals under the rear eave, and the structure frame on the second floor

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	Traditional maintenance methods	Restoration to the original form or appropriate adjustment	Retaining historical information clues
Tiefo Hall	Timber structure, interior wooden decorations, walls, decorative plaster moldings, color painting, and oil painting	Restoration of the damaged timber structure and floor finishing layer between the two ends of the rear eaves (restoration of the original height of the floor)	
Eastern and western overlaid corridors	Timber structure, interior wooden decorations, floor finishing of the eastern corridor, decorative plaster moldings, color painting, and oil painting	Floor finishing of the western corridor (cemented floor to wooden floor), and restoration of steps of the western corridor (cemented steps to wooden steps)	
Yuhuang Hall	Existing timber structure, interior wooden decorations, walls, floors, decorative plaster moldings, color painting, and oil painting	Restoration of the first-floor masonry (changed to wooden ones), the adjustment of the beam frame on the second floor, and the demolition of the suspended ceiling	
Huaigu Pavilion	Existing timber structure, interior wooden decorations, floors, decorative plaster moldings, color painting, and oil painting	Reconstruction of the reinforced concrete (changed to wooden ones)	
Guanlan Pavilion	Existing timber structure, interior wooden decorations, decorative plaster moldings, color painting, and oil painting	Roof tiles and floor finishing (cemented floor changed to stone-slab floor)	

5.3. Restoration of Yuhuang Hall

Yuhuang Hall was rebuilt in the 50s of the last century. The connections between the masonry columns and the concrete floor panel were enhanced by I-beams in 2002. After the earthquake, vertical cracks were found in almost every masonry column, indicating that the building had lost its load bearing capacity. Given that Yuhuang Hall was not designated as a historical building and had been used for nearly 50 years, its style and image had become part of the overall building image as well as a part of public memory. Therefore, it had been decided that Yuhuang Hall should be restored to its original form, preserving its appearance carefully, which includes its windows, doors, and decorations. However, the interior structure was changed to traditional timber, which showed better anti-seismic performance.

5.4. Adjustment of the eastern and western corridors

The eastern and western overlaid corridors and Yuhuang Hall, which were linked to each other, were both timber structures built in last 50s. In view of the inappropriate design of that time, the end of the eastern corridor was inserted into the roof of Tiefo Hall, which damaged the roof structure. During the conservation, the structures of the two corridors were restored after carefully studying their original dimensions. The form and style of the two corridors were maintained, while the staircases at the ends of the corridors made it more convenient to walk up and down (**Figure 9**).

5.5. Using appropriate local craft techniques in the conservation

5.5.1. Decorations on the roof ridge

The decorations on the roof ridge of Fulong Taoist Temple were lively and interesting. The themes were based on local community patterns, including fishes, float grass, Chinese dragons, and characters in mythologies. These decorations were made from cement, grass, and clay materials by local craftsmen. Unfortunately, these decorations, which represent the strong characteristics of traditional craftsmen, were severely damaged by the earthquake. For the conservation, all the fragmented decorations were first collected. Restorations were made to those decorations that had slight damage, while those badly damaged were dismantled and recast by local experienced craftsmen following the local tradition of plaster casting. For those pieces that were lost, the decorations were reproduced by referring to old photos. Since rain occurs frequent in that area, the original paintings on the decorations had faded; hence repainting was also done but strictly only on the missing color parts, while ensuring they had the same color as the original ones (Figure 10).



Figure 9. Eastern corridor after the conservation



Figure 10. Conservation of decorations on the roof ridge

5.5.2. Removing inappropriate additions to history in Huaigu Pavilion

The main load-carrying members (columns and beams) on the first floor were changed into reinforced concrete structures during the maintenance process in the last century. However, the structures on the second floor remained as timber frames. Due to the inconformity of different types of structures, the building had low resistance against the earthquake. In consideration of the safety requirements, it was agreed on that traditional Chinese wooden structures would be used for restoration, while the joinery work, colored drawings, and lime-and-straw decorations on the roof ridges would all be replaced according to their original locations.

5.6. Using appropriate materials

5.6.1. Oil and color paintings

In Fulong Taoist Temple, the main timber frames were painted with dark black lacquer, while the windows and roof were overlaid with red lacquer. Since the Chinese lacquer (main ingredient of oil painting) is sensitive to temperature and humidity, oil painting should be mixed and applied based on the local weather. Local painters were hired to carry out the painting work, so that there would be more appropriate adjustment

on the ratio of painting cycles. For color paintings, if the colors had faded vehemently, color enhancement or repainting was performed. The new colors, however, would not imitate the original colors, but would merely preserve the painting patterns.

5.6.2. Roof tiling

The most apparent damage caused by the earthquake is that most of the roof tiles were destroyed as they slipped to the ground. This is because the roof tiling is a juxtaposition of small grey tiles, meaning that the grey tiles are overlapped with one tile facing downwards, while the neighboring tiles face upwards. The tiles are merely placed on the rafter without any fixation. This is a special tiling method used in southern China, which can reduce the weight of roofs and make it easy to alter when necessary. However, there are drawbacks to this method. These small grey tiles can be easily blown to the ground in windy conditions. Moreover, even small animals can shatter the tiles into pieces when running across the roof. Therefore, the main consideration in this conservation was to maintain the traditional technique while making improvements in its stability. It was suggested for holes to be made in the tiles, followed by nailing the tiles to the rafters. The holes were punctured 5 centimeters from the ends, making it possible for the nails to be covered by the neighboring tiles, thus concealing the areas of human intervention and rendering the overall tiling technique consistent with the traditional one. This method would neither add weight to the roof nor cause the slipping of tiles.

6. The impact of the project on conservation practice and policy

The emergency conservation project of Fulong Taoist Temple is one of the rescue projects after the May 12 earthquake. It is urgent to complete the conservation project as soon as possible, in order to rebuild the local community's confidence and allow them to resume their normal lives. In view of the particularity of this project, the normal conservation work is unable to keep up the speed of restoration. In the face of such a sudden event, design and construction institutions came together to conduct on-site surveys, determine the main principles and targets, as well as precede the conservation work in a timely manner. The foundation of this project lies in the high-efficiency planning, the widely recognized conservation principles, and the complexity of the management in linking every process. In the construction practice, the traditional techniques and traditional materials are adopted with necessary improvements after careful discussion and comparable analysis of different plans, so as to guarantee the consistency and coherence of the conservation treatments in the entire process. The cooperation between conservators and constructors is also enhanced during the implementation. Therefore, the conservation project of Fulong Taoist Temple is a good example of heritage conservation practices for disaster restoration in China, and it is worth improving in the future.

6.1. Complexity, sensitivity, and technical consistency of the methodology

The project adopts the conservation approach, in which the design and construction are executed almost at the same time after establishing the general principles and aims. Therefore, in the restoration process, the cooperation between design and construction institutions should be enhanced on one hand, and the well-studied feasible restoration approaches should be adopted as much as possible on the other hand. The keystone of this project lies on the high-efficiency working plan and the complexity of the management in linking every process. In the construction practice, the traditional techniques and traditional materials are adopted, with necessary improvements after careful discussion and comparable analysis of different plans, so as to guarantee the consistency and coherence of the conservation treatments in the entire process.

6.2. Socio-economic viability and relevance of the project

After the completion of the project, Fulong Taoist Temple, which is open to the public, has been attracting

many tourists from all over the country. On the National Day in 2009, the number of visiting tourists resumed to the same level before the earthquake, which drives the vigor of the city and improves the economic development of the local community.

- (1) This project is not only a conservation for a historic building, but also to rebuild the people's confidence after the earthquake. The project did not follow the usual public bidding system but was directly planned by the national cultural heritage department, with its framework perfected by experts, and its design and construction commissioned. Success was gained in the shortest possible time, and it remarkably strengthened the faith of the people around the disaster area.
- (2) The project's expenditures were covered by the nation. In line with the conservation plan, the national cultural heritage department organized the investigation and approval of the budget as well as directly transferred it to the management authorities of Fulong Taoist Temple and the management committee of Dujiangyan Cultural Tourism Scenic Area. This committee gathered the local community staff and encouraged them to cooperate with the construction company to carry out the conservation.
- (3) After the completion of the conservation, Fulong Taoist Temple is still the main world heritage scenery – Mount Qingcheng and Dujiangyan irrigation system – and the exhibition place of Dujiangyan hydraulic construction and the hydraulic relics of the Han Dynasty for tourists from all around the world.
- (4) After the completion, Fulong Taoist Temple, which is open to the public, has been attracting many tourists from across the country. On the National Day in 2009, the number of visiting tourists resumed to the same level before the earthquake, which drives the vigor of the city and improves the economic development of the local community (**Figure 11**).



Figure 11. The 2009 Completion Ceremony hosted by the State Administration of Cultural Heritage

7. Contribution of the project to the local community

The Fulong Taoist Temple is part of the Dujiangyan irrigation system, which is a world heritage site, under the management of Dujiangyan Cultural Tourism Scenic Area. The temple is one of the most famous sites for tourists and even local communities to visit and learn about the Dujiangyan irrigation system. Besides, this tourism area provides the local community huge economic benefits and employments every year.

Throughout the whole conservation process, the people of Dujiangyan City were actively involved in the logistics service and the conservation project. Just after the earthquake, the people of Dujiangyan actively appealed to the society and the nation for the conservation, and they voluntarily offered themselves in the movement to salvage important relics and exquisite wood components at Fulong Taoist Temple. In the progress of the conservation, the administration of Fulong Taoist Temple continued to organize meetings to discuss on cooperation and services as well as actively promote the effective progress of the conservation, which brought on the recovery of Fulong Taoist Temple over such a short period of time. The project gained admirable support from the Scenic Area Management Department and the local community.

From the 2010 UNESCO Asia-Pacific Heritage Award, the completion of this project not only repaired the damage caused by the earthquake, but also refurbished the display and exhibition of the heritage, resuming its original exhibition function. Most importantly, this project was part of the reconstruction work after the earthquake, which helped the local community overcome their difficulties and rebuild their land (Table 4).

Table 4. Comments from the 2010 UNESCO Asia-Pacific Heritage Award

“Launched in the immediate aftermath of the deadly 2008 earthquake in Sichuan Province, the restoration of Fulong Taoist Temple represents a noteworthy model for post-disaster reconstruction and restoration of cultural heritage. ...Following a rapid damage assessment and the development of general guidelines, the project implemented a restoration methodology that called for design and construction to be executed almost simultaneously. ...The project was carried out in conformity with international conservation principles calling for retention of as much historic fabric as possible and restoration to the last known condition. With its completion achieved in a short 18-month span, the project has restored not only a major monument of outstanding value, but also the confidence and spirit of the people of Sichuan.”

After the completion of the project, Fulong Taoist Temple has been attracting many tourists from all over the country. On the National Day in 2009, the number of visiting tourists resumed to the same level before the earthquake, which drove the vigor of the city and improved the economic development of the local community (Figure 12).



Figure 12. 2010 UNESCO Asia-Pacific Heritage Award

Disclosure statement

The authors declare no conflict of interest.

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