

# **Study on the Fire Prevention Countermeasures about Historic Town in Southwest China**

## **-Taking Xiping Ancient Town in Sichuan Province as the Example-**

黃 凌誌<sup>1</sup> · 張 榮霞<sup>2</sup> · 劉 弘濤<sup>3</sup>

Lingzhi Huang<sup>1</sup>, RongxiaZhang<sup>2</sup> and Hongtao Liu<sup>3</sup>

<sup>1</sup> Postgraduate, Southwest University of Science and Technology, School of Civil Engineering and Architecture  
(Qinglong's Middle Road 59, Mianyang City, Sichuan 621000, China)

<sup>2</sup> Postgraduate, Southwest University of Science and Technology, School of Civil Engineering and Architecture  
(Qinglong's Middle Road 59, Mianyang City, Sichuan 621000, China)

<sup>3</sup> Associate Professor, Southwest Jiaotong University, School of Architecture  
(Southwest Jiaotong University West section, High-tech Zone Chengdu, Sichuan 611756, China)

Most traditional architecture in southwest China is the whole wood material, so that it easy to be fired and cause widespread fires. This article is based on the present situation and the protection of Xiping ancient town in Santai county, Sichuan province of China architectural form, architectural layers, architectural style, architectural structure present situation will be explained, which discussed the reasons for the fire risk in Xiping town, and from building construction, construction safety lighting, architectural surrounding environment and other aspects of proposed fire preventive measures aimed at forming regional characteristics of traditional building fire mode.

*Keywords : Xiping town, Traditional architecture; wooden structure*

## **1 Introduction**

Historical town and traditional architecture are non-renewable historical and cultural heritage, which are the important historical data in the study of history, culture, military and commercial, which are the country or nation's important memory and heritage symbol. The damage would not be measure if our traditional architecture were burnt down. Traditional architecture in southwest China is given priority to the wooden structure, and most of them were built by continuous construction, which is very easy to be breaking out of fire. So, it's very urgent to attach importance to the traditional architecture's fire safety. This paper will explore the cause of the fire and give some solving measures through studying traditional architecture's status analysis, which is the Xiping town in the southwestern china.

## **2 The traditional architecture's status analysis of Xiping town**

### **(1) The Xiping's brief introduction**

Xiping town is located in Santai county, Mianyang city, Sichuan province of china. Xiping adjacent to Zho

ngjiang county in Dengyang city. It is evaluated "the most beautiful town" in Sichuan and it was submitted to the famous historical and cultural town at the provincial level Successfully in 2013. Xiping is near the water in the south and with hills on the back on three sides, it forms the traditional Chinese ancient town's spatial pattern.

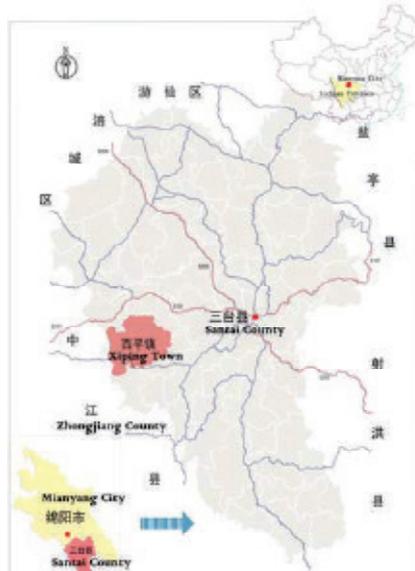


Fig1.1 position of Xiping town in Santai county

Hakka culture and immigrant culture in Xiping town are unique in the culture of Sichuan. According to the historical data, it began to develop when there are 500 residents in Xiping town, and residents are mainly from Fujian, Guangdong, Hunan, Hubei, Jiangxi and other provinces. At present, more than 85% of the population is the migration and the descendants of Hakka from Hunan and Guangdong to Sichuan province. There are Fujian, Jiangxi, Guangdong halls of Xiping town, which the Guangdong hall retains integrity. It has hieron, opera town, façade and so on. The best preserved ancestral hall is Wu ancestral hall, which is the place to ancestor worship, and is also the only one in the Hakka wu's ancestral hall in Sichuan province.

The city wall of Xiping town is the most complete and unique city wall system in Sichuan province. It has two different characteristics. One characteristic is that the wall has four main gates (except south gate) with secondary door. The main gates were used to pass cars. the secondary door were used to pass the passerby. The other characteristic is that the four main gates' direction has 90 degree of error in the actual direction. In order to ensure peace, the ancient people deliberately called north gate as east gate, and called south gate as west gate, which is a measure to confusing the robbers.

## (2)The traditional architecture's status analysis

### a) The roof's form

The traditional architecture of Xiping town was well preserved, Nearly 90% of the buildings are traditional pitched roof structures. These buildings constitute the style of the street space pattern of Xiping town, which has high historical protection value. (table2.1, figure2.1)

Table2.1.Roof plane form Present situation statistical

Category	Quantity	Percent(%)
Slope roof building	101	89.4
Flat roof building	12	10.6
total	113	100.0

(source: Liu Hongtao Studio)



Fig2.1 Roof Plane Current Situation

**b) The distribution of building layers**

Most of the Xiping town’s buildings have only one layer, which is the traditional residential buildings. The buildings height is gentle. And Landscape visual corridor permeability. (table2.2, figure2.2)

Table2.2.Building layers Present situation statistical

Category	Quantity	Percent(%)
One layer	88	77.9
Tow or three layer	19	16.8
Four layer or four layer above	6	5.3
total	113	100.0

(source: Liu Hongtao Studio)



Fig2.2 The Distribution of Building Layers

**c) Traditional architectural style**

As affected by the natural condition and the human factor, the traditional architecture of Xiping town is not adapt to the production and living demands of the users. Some buildings have been renovated and expanded. The architectural style is damaged by different degrees. Our team has inverstigated the architectural features of the Xiping town’s traditional architecture combined with the traditional architectural protection. (table2.3, figure2.3)

Table2.3 Architectural style Present situation statistical

Category	Quantity	Percent(%)
Good architectural style	59	52.2
General architectural style	37	32.7
Poor architectural style	17	15.1
total	113	100.0

(source: Liu Hongtao Studio)



Fig2.3 Architectural Style Evaluation

#### d) Architectural structure

According to the material of building bearing structure in Xiping town, the structure could be divided into five categories, which are civil structure construction, wooden structure, solid wood structure, brick buildings. The most part is wooden structure in Xiping's building structure. Part of the architecture was reinforced or reconstructed to formed brick buildings, brick concrete structure building. (table2.4, figure2.4)

Table2.4. Situation architectural structure

Category	Quantity	Percent(%)
Civil structure	4	3.5
wooden structure	64	56.6
Stone and wood structure	3	2.7
post and panel structure	34	30.1
Brick concrete structure	8	7.1
Total	113	100.0

(source: Liu Hongtao Studio)



Fig2.4 Architectural structure

### 3. Fire prevention countermeasures study



Fig3.1 The west historic street District



Fig3.2 The southeast historic street District

Although the traditional architecture in architectural form of Xing town, architectural style and features, construction quality, etc, are retained in good condition, it is of low moisture content, and becomes easy to burning after years of aging and building materials of wood are dry. Many traditional architecture of xiping town are the construction of contiguous, the fire spacing is small, and fire separation measures is not enough, so that easy to lead burning into tablets (figure1, figure2). Xiping town as one of "the most beautiful town" in Sichuan, it has an important historical, cultural value and the value of tourism development, Therefore, The integrated use of a variety of measures to strengthen the fire prevention of Xiping town has important significance. So in terms of historic building's fire prevention of Xiping town, there are making a few suggestions and solutions:

#### (1) Deal with the building component's Inflammability

Xiping town has been built on the column, beam, fang, purlins, rafter, floors and other major wood components, such as fire retardant coating on wood surface coating or coating, forming a protective layer of fire film, in order to reduce the combustion performance of wood surface, and block the fire spread rapidly. To respect the Xiping's ancient folk customs, making corresponding fire protection layer in a timber floor stairs on the component, in order to improve the fire resistance rating. Meanwhile, For the expansion, renovation and maintenance of buildings, which try to use non-combustible material or flame retardant materials. There are must be used of timber should be soaked in retardant solvent to make flame-retardant treatment, such as the ammonium borate, magnesium chloride and other solvents retardant.

#### (2) Security Settings electrical lighting facilities

If electrical lighting equipment installed in traditional building of Xiping town, it must be approved by the relevant departments, and strictly enforce the electrical safety technical regulations. Relevant data show that 200W bulb close to wood 1h can be ignited; 100W bulb 13min and 200W bulb 5min can make bedding and other combustible materials be ignited. As a result, the lamp in the traditional buildings be better choose 40w ~ 60w. The conductor should choose to have protective layer insulation wire and can not be directly laid on the building timber; switches, sockets should meet the safety requirements.

#### (3) Set up automatic spray fire-extinguishing system

Automatic fire extinguishing system is mainly to take water mist fire extinguishing system, at the same time, it is combined with water spray extinguishing system. Water mist system is the use of water mist sprayer at a certain pressure so that water flows be broken down into droplets out the fire extinguishing or cooling protection. Water mist system would greatly reduce water consumption and reduce water damage hazards. In addition, the pipe network is simple, and is of less damage to historical building structure. At the same time, the protection system is very flexible and can do the whole flood protection as similar as gas, but also for the local protection or partition protected.

According to the historic district investigation of Xiping town, we learned that the distribution of

neighborhoods historic buildings. Therefore, according to the current conditions do fire layout planning (figure 3.2). There will plan to build the water pumps near the Kai Jiang river, while arrange pipeline pumping along the street East, West and the new East. According to the different of building structure, it plans to arrange different extinguishing system in different area of Xiping town. Timberwork building area and civil building will take the water mist fire extinguishing system, through the pipe of each branch end interface connection each building water mist system, so as to extinguish the fire in time. It will use the water spray system in the brick and wood structure, stone and wood structure and masonry structure building range, while combined with the street layout hydrants and other fire-fighting facilities in a timely manner to prevent the spread of fire. In addition, it should be installed the closed automatic sprinkler systems in the important traditional architecture of brick and wood or wood structure (figure 3.3), and should be installed the fixed and mobile water curtain in easy to spread the fire place.



Fig3.2 Xiping historic district building fire system layout plan map



Fig3.3 Situation important buildings map

#### (4) Building surrounding environment remediation

It often needs remove the weeds, dry twigs and other combustible materials near the traditional architecture, at the same time, without affecting the overall landscape of ancient architecture conditions, which repair fire lanes for fire fighting and rescue as far as possible.

#### (5) Regular fire inspection, timely rectification of fire hazards.

Cultural relics protection units, fire units and other departments of Xiping town or three counties by with a purpose, systematic inspection of several organizations each year ,while internal units from time to time to carry out inspections, fire personnel to conduct regular fire inspection. Isolated on risks to be taken on the spot rectification, gradually rectification, rectification of the way, and strive to eliminate hidden dangers in the bud.

## 4. Conclusion

Xiping town's traditional architecture is the southwest China immigrant culture, Hakka culture and the "Hubei and Hunan to Sichuan" important carriers of history, However, Since the age of the building, Construction quality gradually decline and the wooden structure building fire hazards and other reasons, historical buildings protection face huge the challenge. Ancient buildings entities should be attached importance to be protected by all departments. A resident who living in a historic building should consciously raise awareness of protecting traditional architecture, and Inheriting excellent historical and cultural heritage in our country.

**Acknowledgment:** We would like to thank the various people who provided useful advices and helpful assistance during the whole writing process. Special appreciation goes to the all members of Liu Hongtao Studio(劉弘濤研究室), for their intelligent insights and rigorous analysis. This article is part of the Liu Hongtao Studio(劉弘濤研究室) research results.

## References

- 1)Xingping Quan: Ancient building fire safety problems and Countermeasures -- take Zigong Salt History Museum as the example, *J. Technological innovation guide*, 2010.3.5
- 2)Hongtao Liu , Xuan Wang: Study on the Fire Defense Problems in Traditional Settlements in Southwest China--Taking Shangri-La in Yunnan as the Example, *J. Journal of Disaster Mitigation for Historical Cities*, Vol. 9, pp. 207-214,2015.6.
- 3)People's Republic of China Cultural Relics Protection Law Implementing Rules
- 4) Ministry of Public Security Fire Department: Check the manual fire, *M. Shanghai: Shanghai Science and Technology Press*,1992.
- 5)Huangxiao Jia., Jiangwen Yuan: Automatic Sprinkler System Design Manual, M. Beijing: China Building Industry Press,2002.
- 6)Liu,Jing.: Fire Prevention and evacuation measures Ancient Buildings, *J. Fire Science and Technology*,Vol.24, 2005.09.
- 7)Yuji Morishita: A Study on Earthquake Fire in the City of Edo, Fireproofing Japanese traditional town houses, *J. Disaster Mitigation of Cultural Heritage and Historic Cities*,Vol.7,pp.139-144,2013.7.
- 8) Liu Hongtao Studio: The present situation investigation of historical block in xiping town, 2014.09.