

# **RECONSTRUCTION OF POST-EARTHQUAKE FIRE IN INARIYAMA POST TOWN**

NAKAO Miho and TANAKA Takeyoshi  
Disaster Prevention Research Institute, Kyoto University  
Gokasho, Uji, Kyoto 611-0011, JAPAN  
[nakao@drs.dpri.kyoto-u.ac.jp](mailto:nakao@drs.dpri.kyoto-u.ac.jp), [takey@drs.dpri.kyoto-u.ac.jp](mailto:takey@drs.dpri.kyoto-u.ac.jp)

## **ABSTRACT**

It is well known that due to the Zenkouji Earthquake occurred at 10 p.m., 24 March 1847, tremendous houses were destroyed and fires broke out to claim a heavy toll of human lives in the city of Zenkouji. But it isn't necessarily known that Inariyama, a post town located at some distance away Zenkouji, was entirely destroyed by the fires that broke out after the earthquake. So on the basis of topographical data, the records on houses and pictures that show the spreading course and the burnt area of the fire, an attempt was made to reconstruct the state of Inariyama post town at the time of the Zenkouji Earthquake and the fire spreading state in Inariyama post town.

## **1 INTRODUCTION**

The recovery of any society struck by a severe disaster is not done in a short period of time such as two or three years after the disaster, it takes much longer period of time. This study aims to reconsider the process of restoration from such a historical disaster. Our society today is constructed upon the debris of the disasters in the past, so the reconsideration of historical disaster is very important to understand how our society is affected by great disasters such as earthquake in Hansin and Awaji and the disasters that are possible to happen in the future.

But it is difficult to know the damage of historical disaster, so that the date about the situation of damage is only ancient documents and pictures, an animation such as television that is easy to grasp the situation of damage does not remain. So this reconstruction of earthquake fire in Inariyama post town attempts to know the damage.

## **2 OUTLINE OF THE ZENKOUJI EARTHQUAKE**

The Zenkouji Earthquake is a great earthquake, occurred at 10 p.m., 24 March 1847. It's damage extended as wide as from Shinano to Echigo districts, it has been estimated that the Zenkouji Earthquake was of the magnitude over 7.4 on the Richter scale and the tremor of the 7th degree on the seismic scale. In addition to the destruction of tremendous houses by ground shaking, great disaster such as fires, landslides and floods occurred in this earthquake. Particularly, the floods and the rips on the earth and sand caused by landslide are famous, but the damages due to the fires, which broke out in a number of areas, were tremendous too. Those severe secondary disasters claimed

nonetheless heavier tolls of lives than the first strike of the disaster. The time Zenkouji Earthquake occurred was in the midst of the ceremony of exhibiting a very famous Buddhist image, held once every seven years in Zenkouji, a great number of people were visiting to the shrine from over the country. In the earthquake, many travelers who were staying in Zwnkouji and near by post towns were killed under the debris of the destructed houses. The outline of the Zenkouji Earthquake is summarized in Table 1.

Table 1: Outline of the Zenkouji Earthquake

Time of the Earthquake	10 p.m. 24 March (8 June, New Style) 1847 (in the 4th year of Kouka)
Size of the Earthquake	over 7.4 on the Richter scale over a tremor of the 7th degree on the seismic scale
Seismic Center	at 137.2° west longitude 36.7° north latitude Nagano Basin Japan
Death Toll	12,000
Feature	the severe secondary disaster such as fires, landslides and floods occurred in addition to the first damage such as the collapse of houses and ground breaking

### 3 OUTLINE OF THE INARIYAMA POST TOWN FIRE

Fig.1 shows the damage of the fires, floods and landslides occurred by the Zenkouji Earthquake, the fires broke out at the areas shown by red color, the foods happened at the blue area along river and the landslides occurred at the yellow areas. The landslides intercepted rivers and floods occurred as the dams formed by the landslides eventually collapsed, as shown in Fig.1. Inariyama post town was on Zenkouji Highway that was prosperous in the period of Edo and located now in Koushoku City, Nagano, which lies in the south of Zenkouji. Fires also broke out in Inariyama post town by Zenkouji Earthquake.



Figure 1: Picture of the state of the Zenkouji Earthquake [2]

### **3.1 Inariyama Post Town at the Night of Zenkouji Earthquake**

As said in the above, the time Zenkouji Earthquake occurred in 1847 was in the midst of the ceremony of exhibiting a Buddhist image in Zenkouji, a number of people were visiting to the shrine from all over the country, it seemed that the presumably one thousand of travelers stayed in Inariyama post town at that time. Also Inariyama was a business town, so it seems that many of merchants, foragers and servants in addition to the traverses from far and near villages stayed as well. In Inariyama post town, most of the houses collapsed and fires broke out. Many people were trapped under the debris and burnt to death by the fires that followed the earthquake.

### **3.2 Human Harm in Inariyama Post Town**

Ryudouin and Gokurakuji temples still keep the necrologies that recorded the names of victims who were killed by collapsed houses and by fires, 24 March. According to the necrology of Ryudouin temple records, thirty-four men, forty-nine women and thirteen travelers were killed. The necrology of Gokurakuji temple indicates that thirty-eight men, fifty-five women and twenty-two travelers were killed. On the basis of these necrologies, the total number of the dead is one hundred eighty-nine, but it was said that actual number of the victims was more than these number. According to the written material by Matsubayashi Yagoemon, a town headman at that time, the damages in Inariyama post town from 24 March on, 170 residents, 70 lodgers and 150 travelers were victimized.

## **4 RECONSTRUCTION OF INARIYAMA POST TOWN**

At first, this study attempts to reconstruct geographical condition of Inariyama post town at the time Zenkouji Earthquake in 1847, on the basis of the data as follows in 4.1 - 4.5.

### **4.1 Geographical Features**

Because the topographical information at the time of the earthquake is not available, this reconstruction is based on the Inariyama land survey in 1858 [3] shown in Fig. 2, assuming that the geographical appearance was not far different from that in 1847, and present-day maps. At that time, the houses stood closely together along the main street. The area enclosed with white broken line in Fig. 2 shows the rough area that covers Inariyama post town. It seemed that the outskirts of the town consisted of farms and bushes.

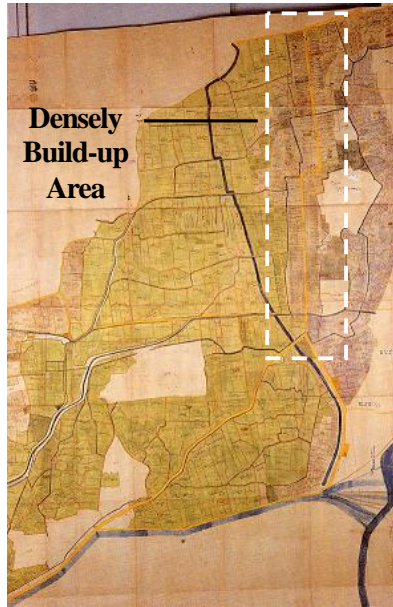


Figure 2: Picture of Inariyama land survey in 1858 [3]

#### 4.2 Layout of Inariyama Post Town

The Inariyama land survey map in 1858 (Fig. 2) let us know the land feature in and around area. On the other hand, the map of Inariyama post town (Fig. 3) gives more detailed layout of Inariyama town including each house lot in the town. Although the exact scales of these maps are not available, the main streets, shown at the blue lines in Fig. 3, has not changed up to now, so by comparing the length of the main streets in Fig. 2 and in the present-map, the accurate scale and map at the time of 1858 can be calculated. Fig. 3 shows the new map thus reconstructed.

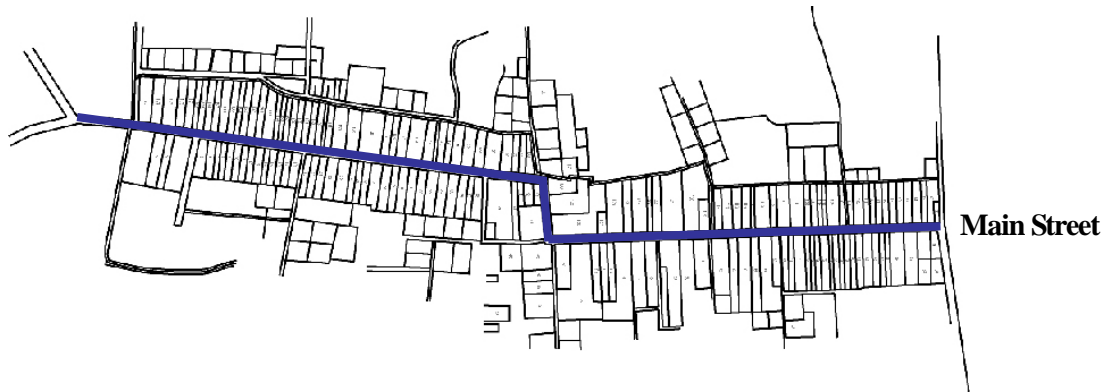


Figure 3: Reconstruction of layout in Inariyama post town

### 4.3 Dimension of House

The houses are arranged accurately on the map based on the Matshubayashi's document [4] that records the disaster relief fund paid to the sufferers in proportion to the size of houses and according to the level of damage. Table 2 shows a part of the records. It is considered that main houses fronted on the main street had been elected, leaving almost no space between them and the warehouses and the sheds had been arranged in the rear of main houses on each site judging from the proportion and the layout of the houses. This is the same arrangement as many other post-towns seen over the country in that period.

No information of house's dimensions like Table 2 is available about the houses along the sides of Motoyokamachi Street (right side in Fig. 3), so their arrangement has been inferred from the information about the houses on Aramachi-Nakamachi Street (left side in Fig. 3).

Table 2: The part of the Matshubayashi's document [4]

Street	Landowner	Number of Rent	House		Warehouse		Shed		
			Note	Dimension*	Dimension*	Damage	Note	Dimension*	Damage
Terakouji	Tokunosuke		Medicated Bath	1× 2.5					
	Matubayashi Gennosuke			7× -	2× 2	Partial	Warehouse		Collapse
	Yasuke			3.15× 5				2× 1.5	
	Iuzaemon	4		4× 5.5	3× 2		Warehouse	6× 2	Collapse
	Shukiti	1		6× 4	2× 4/ 3× 2			5× 2	Collapse
	Jukiti			Tiled Roof	3.5× 6				

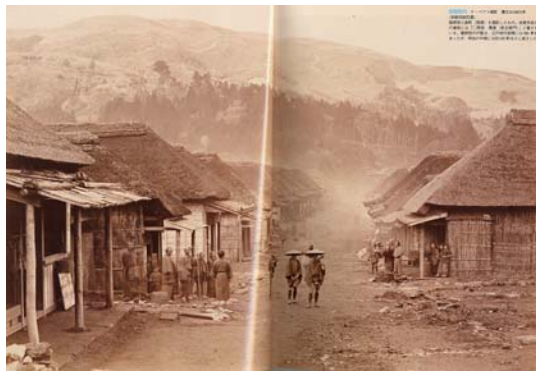
\* Unit: Ken (1ken = 1.8m)

### 4.4 Shape of House

The shape of houses such as roofs and windows are based on the photo pictures and the landscapes of various post towns in the last days of the Tokugawa Shogun age, the early days of Meiji era and the pictures in Zenkouji Earthquake as shown in Fig. 4.

According to such photos and pictures, it is considered that tiled roofs were popular in big cities such as Edo and Osaka, but straw roofs were rather currents in districts apart from the big cities at the time of the last days of the Tokugawa era.

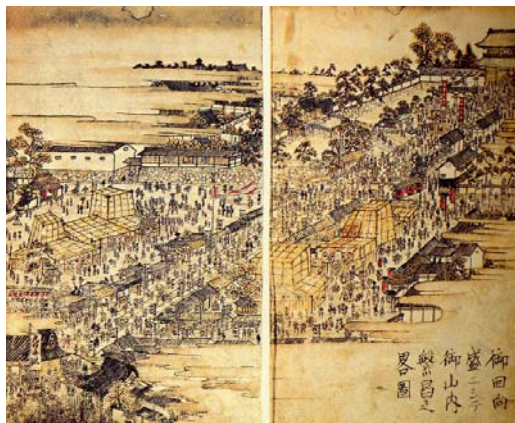
Fig. 4(b) shows a picture that shows the state of Zenkouji post town in the first period of 1840, before Zenkouji Earthquake. The roofs of main houses were straw roofs, and only the part of pent roof was shingle roof. It is considered that the shape of houses was similar in many towns around Zenkouji including Inariyama post town. And, in Matshubayashi house records [4] exemplified by Table 2, the indication of tiled roof is few, so in this attempts to reconstruct Inariyama post town, it is assumed that the roof of a main house was straw roof and the pent roof was shingle roof.



(a): Hakone post town in 1867 [5]



(b): Zenkouji post town before the Zenkouji Earthquake in 1847 [6]



(c): Ceremony of exhibiting a Buddhist image in Zenkouji just before the Zenkouji Earthquake in 1847 [7]

Figure 4: The state of post town from the last days of the Tokugawa Shogun age to Meiji era

#### 4.5 Honjin

The Honjin, an officially appointed inn for daimyos and their followers, existed in Inariyama post town. “Noted Places Along Zenkouji Highway” [6], which is a book that introduced sights seeing spots around Zenkouji for travelers, recorded the Honjin in Inariyama before the Zenkouji Earthquake. It said that the width of the gate was nine shaku (is 2.7 m) and was constructed with four pillars. The picture of the gate of Honjin is shown in Fig. 5. The floor plan of officially appointed inn in Inariyama is shown in Fig. 6 [8], although it was after the Zenkouji Earthquake that the plan was drawn. The shape of Honjin is based on the pictures and landscapes of Zenkouji around 1847 as shown in Fig. 4(c). On the basis of these pictures, an attempt was made to reconstruct the Honjin in Inariyama, the picture of reconstructed the Honjin is shown in Fig. 7(c).

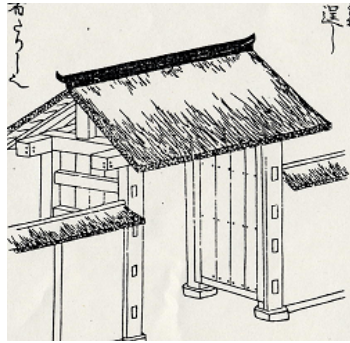


Figure 5: Gate of the Honjin in Inariyama [6]

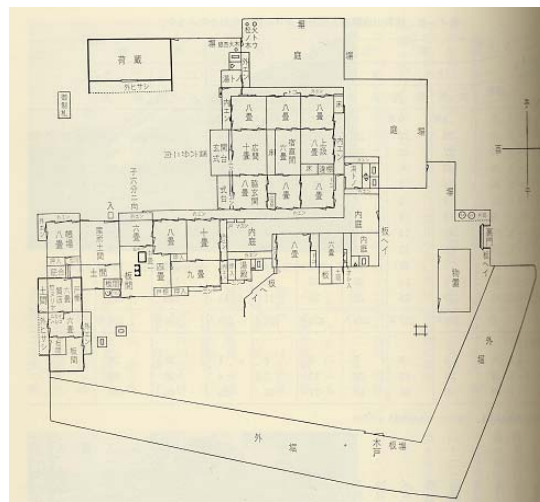


Figure 6: Floor plan of the Honjin in Inariyama [8]

#### 4.6 Reconstruction Picture

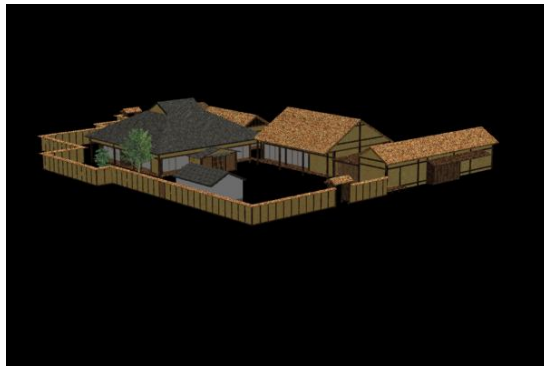
Fig. 7 shows the state of Inariyama post town at the time of Zenkouji Earthquake reconstructed on the basis on the materials presented in 4.1 - 4.5. The plans of topography and houses and the Honjin are drawn using Vector Works, and the animations of them were made using Shade. The solar altitude at the time of Zenkouji Earthquake 24 March (8 June, new style) in 1847 was investigated, so shadow is reflected in these pictures. Fig. 7(a) shows the bird's-eye view of the town, Fig. 7(b) shows a part of the row of stores and houses along the main street, and Fig. 7(c) shows Honjin.



(a): The state of Inariyama post town



(b): The row of stores and houses of Inariyama post town



(c): The Honjin in Inariyama post town

Figure 7: The reconstruction of Inariyama post town at that time of Zenkouji Earthquake

## 5 RECONSTRUCTION OF THE FIRE SPREAD IN INARIYAMA POST TOWN

### 5.1 Materials on the Fires in Inariyama Post Town

The Zenkouji Earthquake destroyed many houses, and fires broke out at four different locations. Fig. 8 shows the areas destroyed by each of these fires. On the basis of this map and the description of the fires described by one Matsubayashi Yagoemon, the first fire started immediately after the time of the quake, around 10 p.m., and destroyed eighteen houses. The second fire started around 11 p.m. that burnt down eighty-five houses before it was naturally extinguished around 10 a.m. in the following morning. The third fire, which destroyed thirty-four houses, began around 7a.m. and extinguished in the same morning. The last of the four fires was also started and extinguished that morning, leaving eighty-three destroyed houses as shown in Table 3. The total of 220 houses were burnt to ash; only sixty houses and twenty warehouses were left intact. The time of the outbreak of the fires, extinguishments of fire and the number of burnt houses in each fire are comprehended fragmentarily. But the information is not complete, so the unknown part is also significant.



Table 3: State of the fires in Inariyama post town

Fire	Outbreak Time	Outbreak Place	Extinguishment Time	Extinguishment Place	Burnt Houses
(1)	3/ 24 10pm	the middle at the west side of the Honvouka town street	-	-	18
(2)	3/ 24 11pm	the middle at the west side of the Ara town street	3/ 25 10am	-	85
(3)	3/ 25 7am	the south at the east side of the Honvouka town street	3/ 26 in the morning	-	34
(4)	-	the south at the east side of the Kamivouka town street	3/ 26 in the morning	-	83



Figure 8: Map of the Inariyama post town [9]

## 5.2 Estimation Of The State Of Fire Spread

The description on the weather conditions, particularly the direction and velocity of the wind at that time, which must have had a great influence on fire spread, doesn't exist. By this reason, it is impossible to estimate the velocity and the direction of the fire spread, so it is assumed that the velocity of the fire spread of each fire is uniform and, it is tried to estimate and reconstruct the stages of the fire spread by complementing the deficient information such as the time of outbreak of the fire, with rough assumptions.

The time of the outbreak and extinguishments of the fires are accurate concerning Fire (2), but the other fires don't have information either of the outbreak time or extinguishments time, so only the velocity of fire spread of Fire (2) can be estimated. The burning time of Fire (2) can be calculated as eleven hours from Table 3. The distance of burning area of Fire (2) can be measured from Fig. 8. So the velocity of fire spread of Fire (2) can be estimated using the burning time and the distance. In regard to Fire (1), though the time of extinguishments of fire are not clear, the fire occurred in the same time as Fire (2) and it is estimated that the weather conditions at Fire (1) is the same, so it is regarded that the velocity of fire spread of Fire (1) is the same velocity as Fire (2).

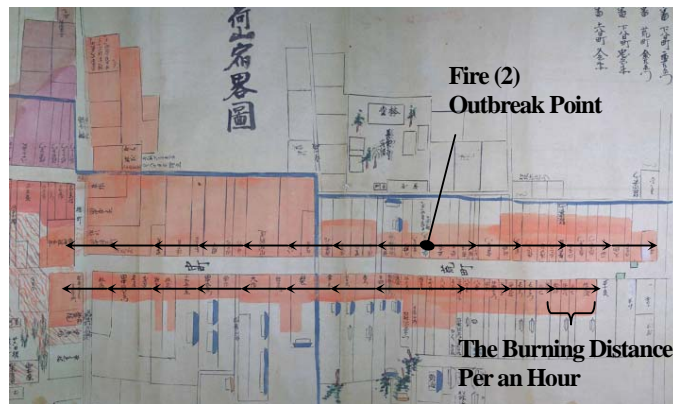


Figure 9: Estimation of the velocity of the fire spread of Fire (2)

### 5.3 Reconstruction Picture Of Fire Spread

Fig. 10 shows stages of the fire spread at some representative hours after the outbreak of the Zenkouji Earthquake.

#### (a) The fires just after Zenkouji Earthquake, 24 March (Fig. 10(a))

Just after the earthquake occurred at 10 p.m., in 24 March, the first fire (Fire (1)) broke out at Motoyokamachi Street in Inariyama post town.

#### (b) The fires at midnight, the day of the quake (Fig. 10(b))

Around midnight, 24 March after two hours from the outbreak of the earthquake, the first fire (Fire (1)), which started at Motoyokamachi Street just after the earthquake, spreaded to north, and the second fire (Fire (2)), which broke out at Aramachi Street at 11 p.m., spreaded to both south and north and at the same time flames leaped to east and spreaded.

#### (c) The fires at 7:30 a.m., the following morning (Fig. 10(c))

At 7:30 a.m., 25 March, Fire (1) burnt down to a section of front and rear of the west side of Motoyokamachi Street, and is likely to extinguish. The third fire (Fire (3)), which started at Motoyokamachi Street around 7 a.m., spreaded to north along the street and joins Fire (2) that advanced south ward. Fire (3) spreaded the rear of west side of Motoyokamachi Street to north after that.

#### (d) The fires at noon (Fig. 10(d))

Around noon, 25 March, the fourth fire (Fire (4)), which started at the east side of Kamiyokamachi Street, spreaded to north. After that the fire went on spreading and entirely destroyed the most of the houses that remained till then.

Namely, the fire (Fire (1), (2)), that started around 10 p.m. accompanying with the outbreak of the earthquake, burnt completely the both sides of Aramachi and Nakamachi Street that covered north half area of Inariyama post-town around dawn. After the dawn of the following day, the velocity of the fire spread became slow, but the fire (Fire (3)), which broke out at the south area in east side of Motoyokamachi Street, went up north and destroyed entirely the rear area in west side of Motoyokamachi Street that had remained unburnt till then. The one-third of the urban direct still remained till evening, but the fire (Fire (4)), which was at south area in the east side of Kamiyokamachi Street, kept on spreading yet after sunset and burnt down most of the houses fronting the street and extinguished around the morning of the day after next.

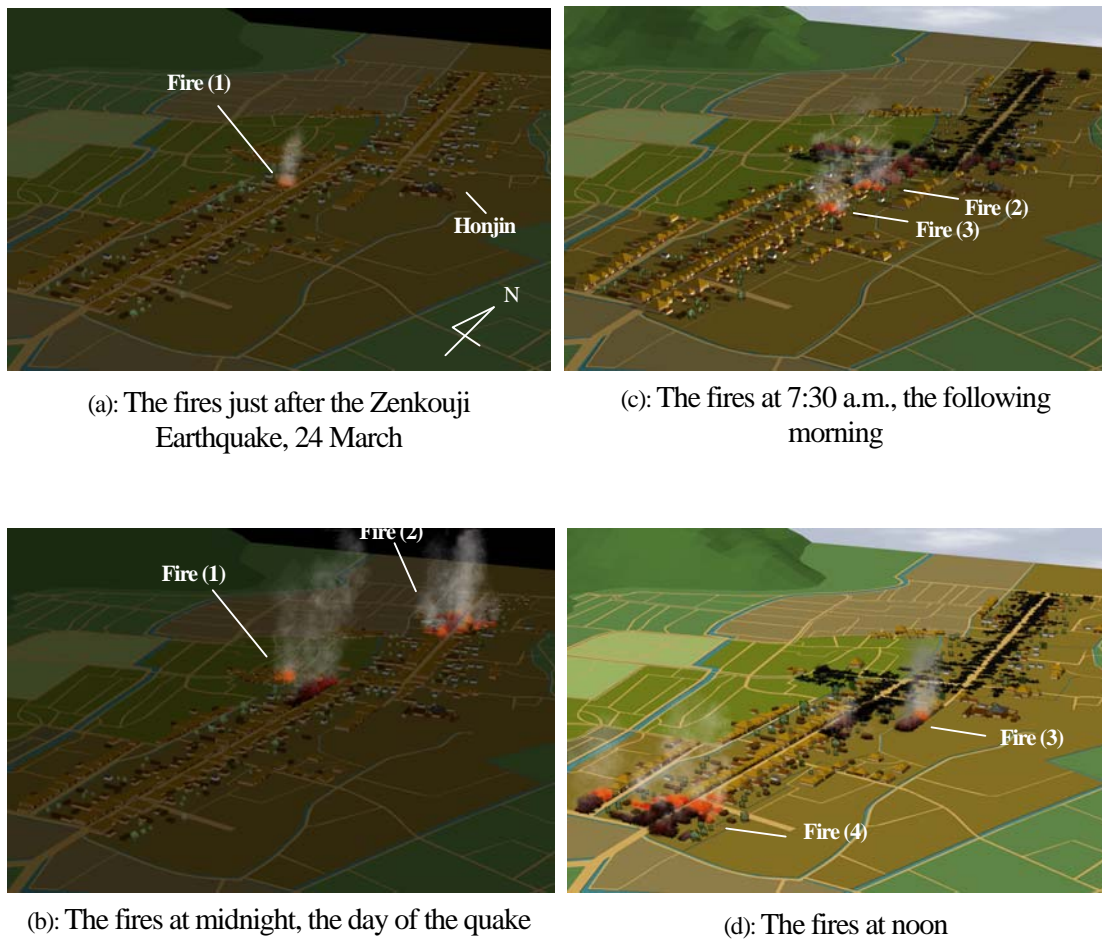


Figure 10: Reconstruction picture of the fire spread in Inariyama post town

## 6 CONCLUSION

In Japan, the damage of urban cities by earthquake fires in the present day is a very big concern. It is difficult to understand the state of earthquake fires by using experiments, so it is very important to learn lessons from the past records. But the information is limited, so an accurate reconstruction is difficult. On the other hand, by the reconstruction of the fire using modern tools like CAD, it seemed easy to grasp more concrete picture of the fire at that time, in comparison with fragmentary descriptions and map in ancient documents, so advantageous in leaving lessons from the disasters in the past.

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