

JAPAN

Protection of Wooden Cultural Heritage from Earthquake Disaster

National treasures and important wooden cultural heritage places of Japan are mostly concentrated in Kyoto, Nara and Tokyo. Particularly in Kyoto, cultural heritage places are scattered with high density in the relatively small basin, which is incomparable with any other city and/or town. Case studies have been conducted to develop a protection system from post-earthquake fire for the oldest wooden temple structure in the Kyoto basin, making use of a water curtain. A fire extinguishing system is also proposed for the historic conservation area covering the hillsides of the Kyoto basin. The results are to be adopted in a project of the Japanese government to establish a post-earthquake fire protection system.

The vulnerability of Kyoto cultural heritage places at risk from the Nankai and Tonankai earthquakes

Earthquake disaster management of the Japanese Government

The Japanese Government reformed the administrative system in January 2001 and new ministries and agencies have been established. The Cabinet Office is one and given a relatively higher status than the other ministries. The Office has four major councils to advise the Prime Minister on important issues. The Councils are on Economy and Fiscal Policy, Science and Technology Policy, Central Disaster Management Council, and Gender Equality, respectively.

As indicated above, earthquake disaster is one of the most important issues for the Japanese Government. Therefore, after the revision of the administrative system of the central government, the Cabinet Office began to establish technical committees to discuss important issues regarding earthquake disasters. One of them is the Committee for the Tonankai and Nankai earthquakes which are inter-plate earthquakes in the subduction zone along the Pacific Ocean. This committee, however, deals with not only inter-plate earthquakes but also intra-plate earthquakes occurring on the inland zone of [the] Japanese islands.

Figure 1 shows the distribution of active faults around the

Japanese archipelago. As shown in the figure, inland active faults are concentrated with a high density in the central part of the main islands of the Japanese archipelago, namely the central mountain area and the Kinki district which include old capital cities such as Kyoto and Nara.

Kyoto, Nara, Osaka and Kobe are major cities designated as Government Ordinance and these cities are relatively separate from the major subduction earthquake zone. On the other hand, these major cities are surrounded by inland active faults. The Japanese Government started a research project on 98 active faults in 1995 and will finish in 2004. This research revealed many scientific facts about the active faults by excavating trenches across the faults, namely the period of every fault's past activities, the amount of dislocation and so on.

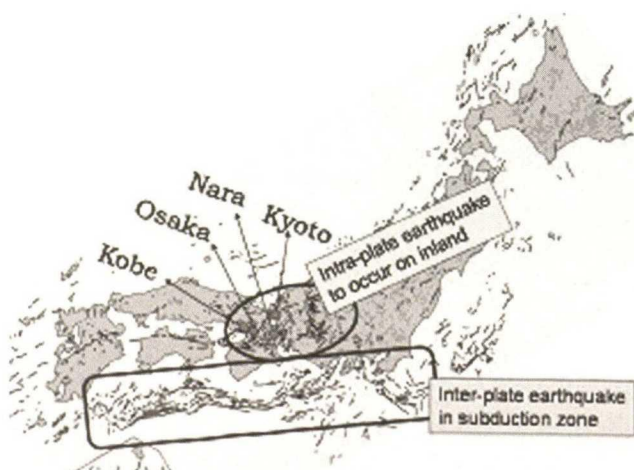
Cultural heritage in the Kyoto basin

Nara was the capital of the first centralised government of Japan in the 8th century. After that, Kyoto was the capital of Japan from 794 until the capital was transferred to Tokyo in 1869. During these periods, many temples and shrines were built and lost, mostly from post-war fires in Nara and Kyoto. Still today however, the density of cultural heritage places in Nara and Kyoto is very high compared to other areas as shown in Figure 2.

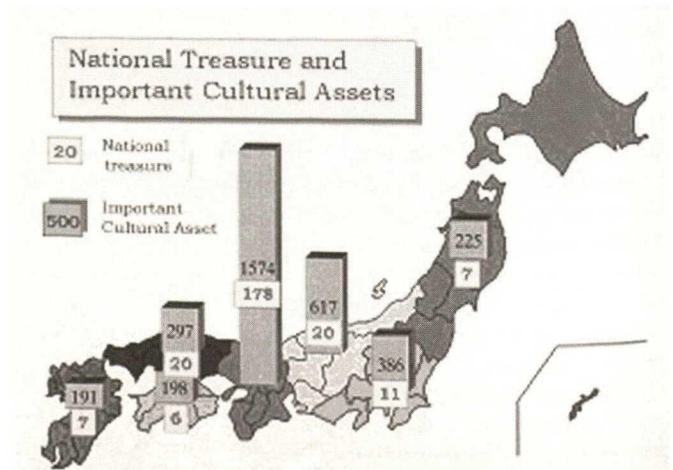
As shown in the figure, more than 70% of national heritage places are concentrated in the Kinki district which unfortunately coincides with the location of the surrounding inland active faults as shown in Figure 1. This is the reason why we are anticipating that the cultural heritage places in the Kinki district will suffer from the next major earthquake, probably caused by the inland active fault.

The total number of national treasures in Nara is almost the same as that of Kyoto but the density of that in Kyoto is quite high compared with that of Nara. This is because important cultural assets and national treasures in Nara are dispersed among villages and towns and the density per unit area is not as high as in Kyoto. On the other hand, the number of National Treasures per 100,000 people in Kyoto is 135 and this is much larger than that of 30 in

Active faults around the Japanese archipelago



Distribution of National Treasures and important cultural assets



Tokyo. This implies that Kyoto is the most endangered city in terms of the vulnerability of its cultural assets against earthquake risk.

Kyoto was the capital of Japan for eleven hundred years before it moved to Tokyo 130 years ago. Therefore there are many cultural heritage items, not only built structures but also movable artistic assets. More than twenty percent of the national treasures of Japan are concentrated in the Kyoto basin, a relatively small area of 12 km by 15 km. Considering that the occurrence of strong earthquakes due to inland active faults surrounding the Kyoto basin is anticipated within the next few decades, analysis of the risk of cultural heritage places in the Kyoto basin burning down should be assessed for all the wooden buildings that are designated national treasures.

Lessons Learnt by the Kobe Earthquake in 1995

The vulnerability of existing fire extinguishing systems of temples and shrines in Kyoto

During the 1995 Kobe earthquake, the fire-extinguishing systems of two temples with high status in Kyoto broke down due to a break in the pipe connecting the water gun to the reservoir. Kyoto is about 50–60 km away from the epicentre of the Kobe earthquake and this fact made us aware of the vulnerability of the temples' and shrines' buried water pipe systems. Once a strong earthquake hits Kyoto, the Kyoto basin will be extensively shaken and most fire-extinguishing systems will be disrupted.

On the other hand, after the main shock of the Kobe earthquake, the post-earthquake fires occurred simultaneously in many places in Kobe and more than 7,000 houses were burned down. More than 10% of casualties lost their lives to fire. The percentage of wooden houses older than 50 years in Kobe was about 6.9% but that of Kyoto is 15.9%. This means that Kyoto is much more vulnerable to fire than Kobe.

These facts imply that many fires will take place and the fire-extinguishing systems of the temples and shrines will be disrupted when a major earthquake hits Kyoto.

The difficulty of restoring community heritage places damaged by earthquake

Many cultural heritage places were damaged by the Kobe earthquake in 1995. In Japan, cultural heritage places are categorised according to historical value. Many historic properties exist in Japan, from national treasures to local buildings of community heritage importance. Generally, the buildings listed by the nation are considered to be in the most important category according to public esteem. In this category, buildings with the highest authority are called National Treasures. Buildings listed at the prefecture level are in the second-highest rank, and those approved by the municipality are in third position, and those not approved by any group are in the lowest rank of public standing.

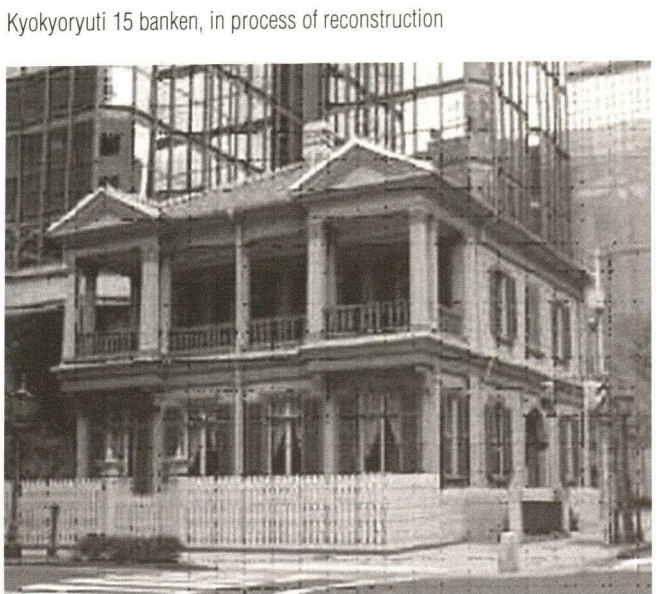
Today, detailed research makes clear the number of cultural heritage places damaged by the 1995 Kobe earthquake. The number of nationally listed damaged buildings is 33, listed by prefectures is 44, and approved for listing by municipalities is 22. The number of nationally listed reconstructed buildings is 33, those prefecture listed is 42, and municipality listed is 19. Most buildings listed by some level of government survived. At the same



Kyokoryuti 15 banken before destruction



Kyokoryuti 15 banken, destroyed by earthquake



Kyokoryuti 15 banken, in process of reconstruction



Lost community heritage (Sarankaku)



The Kiyomizu temple, World Heritage area

time, it is clear that many local community heritage buildings not listed by any government body disappeared in the Kobe earthquake. From the AIJ (Architectural Institute of Japan) survey we know that about 30% of the buildings disappeared that were not listed at any government level.

Kyukyoryuti 15 bankan was nationally listed in 1989 and used as a Chinese restaurant. This heritage place was completely destroyed by the Kobe earthquake in 1995. The owner needed a large amount of funds for reconstruction, approaching 860 million yen. But as this building is nationally listed, the owner got a large subsidy from the national government. In addition, because the Kobe earthquake caused serious damage, the grant level was raised by the national government. In the end, the owner bore 5% of the reconstruction costs.

Sarankaku, in which Junichiro Tnizaki, a great Japanese literary figure, lived for 3 years, was completely destroyed by the Kobe earthquake in 1995. Ninety million yen were needed to reconstruct the building. It had not been listed by any level of government and the owner did not get any great subsidy from any group. The committee for the reconstruction of *Sarankaku* gained the cooperation of the mass media and asked for donations. But the committee got less than one tenth of the necessary funds to reconstruct the building.

In comparing *Kyukyoryuti 15 bankan* to *Sarankaku*, it is clear that there are great differences in terms of funding. Local buildings of community heritage, not listed by any assembly, could not get enough money, and they are doomed to be condemned in a great earthquake. Against that fact we must keep buildings that are important to local community heritage.

Risk Finance to prepare for disaster risk

It is useful to think of preparedness funds on a routine basis for ruins. Using earthquake insurance is one of the best solutions to get sufficient funds for reconstruction. Insurance is a system which is sympathetic to the weak. Even if someone has little financial credit, those signing up to insurance can provide for an emergency, just by paying a fixed insurance fee a year. But Japanese

earthquake insurance has in essence three problems. One is that the contract amount is limited to between 30% to 50% of fire insurance which is under contract with an insurance company. The other is that signatories cannot gain insurance money at a rate proportional to the amount of damage. Another is that the insurance money is capped at 50 million yen. It is difficult to solve these problems, because earthquakes are a disaster risk. It makes designing an insurance system difficult. But if these problems are solved, accession to earthquake insurance provides an excellent way of Risk Finance to prepare for the risk of disaster.

Increasing the number of Inscribed Heritage Buildings is another solution to preserve buildings such as community heritage places. In Japan, the Government established the Inscribed Heritage system in 1996. The owner inscribes local community heritage buildings that are not approved by listing by any other bodies on the list of Inscribed Heritage Buildings. When the inscribed building is badly damaged, the owner gets a subsidy which is less than for a listed building. But in the case of inscribed buildings, it is permitted to change the appearance and the interior flexibly for constructive use. This system is useful not only to get a subsidy but also to motivate the owner and supporters to increase their awareness about preserving heritage. The number of buildings appearing on the list in Japan is far less than in the United States of America. It is important to increase the number of Inscribed Heritage Buildings.

The value of heritage depends on individual beliefs. Some people think *Kyukyoryuti 15 bankan* is more important than *Sarankaku*. But some people think *Sarankaku* is more important than *Kyukyoryuti 15 bankan*. Whether a cultural heritage building is approved or not, citizens' motivation for heritage preservation is the most important factor.

Risk Control with a Safe Environment

Proposal for an Environmental Water Supply System in Kyoto

It is true that the risk finance to prepare for disaster risks is important, but risk control to reduce the level of damage is also essential. Regional resources such as natural water and citizen participation provide a great potential for risk control in the case of earthquake fire.

During the Kobe earthquake, serious damage to modern infrastructure was caused by the lack of water for fire-fighting, and at that time, natural water within the neighbourhoods was used. It is important to improve this potential for urban natural water and citizens' participation as 'Environmental Water Supply System (EWSS) for Disaster Prevention' which is maintained and protects wooden cultural cities from fire and preserves urban water.

Concepts of Environmental Water Supply System

The concepts of EWSS were found in the experiences of the Kobe earthquake. These systems need to be built by various kinds of water resources to maintain a water supply at any time, and the right amount of water to enable fire-fighting at multiple levels from small fires to spreading fires.

An Estimation of the Earthquake Fire Hazard Area in Kyoto

Kyoto City, one of the historical cities in Japan with many wooden cultural heritage places, is selected as a case study district for planning an EWSS. The characteristics of the city area are analysed according to the percentage of elderly and the average number of persons in each family as the index of fire risk, and the amount of wooden structures as the index of the risk of the fire spreading.

In addition, the risk from earthquakes in being able to isolate fires is analysed from the width of roads around the area. The possibility of a fire spreading from a neighbourhood to cultural heritage places is checked also by simulating the spread of such a fire.

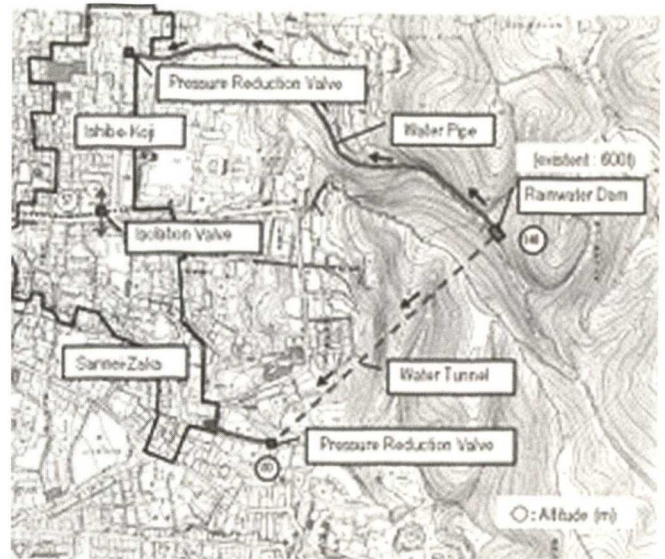
The results show that The Sannei-zaka Historical Preservation District in the World Heritage Area is one of the most endangered areas of all the nationally listed heritage conservation districts in Kyoto.

Case Study Planning of EWSS in the Sannei-zaka Historical District

Achievable plans for EWSS in Sannei-zaka Historical Preservation District are designed by researching the geographical characteristics around this area.

It uses existing natural water as the resource from a small dam 80 m higher using gravity for water pressure. The easily operated hydrants and the sprinkler nozzles are placed to deliver functional fire fighting water to citizens in this district, and also, some cisterns beside the river are added as a back up for this system. The dam will be able to keep sufficient water for at least one hour of fire-fighting by this EWSS.

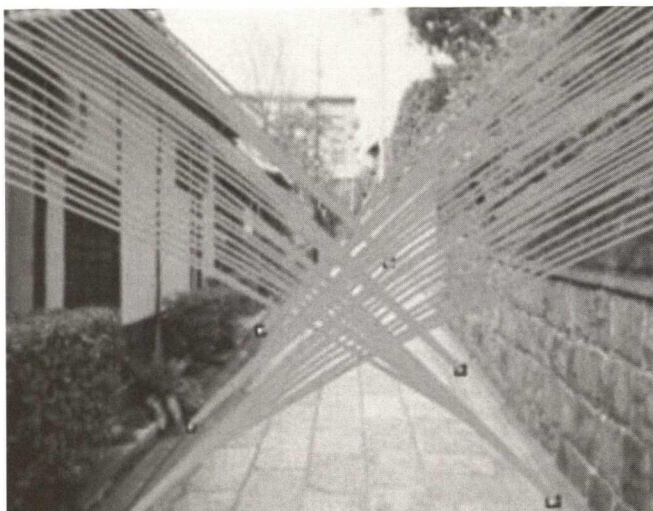
It is important for us to regain the natural water environment in urban areas. We should create a safe and pleasant environment that preserves wooden cultural heritage structures in communities as well as modern structures. The concept of EWSS emphasises the necessity of a sustainable water environment and the restoration of the historical atmosphere with its aesthetic values and safety from natural hazards. The outcome of this research can be readily applied to similar problems in developing countries by making use of their skills and low cost technology. It is our obligation to preserve and pass irreplaceable cultural treasures to future generations, without damage caused by natural disasters.



Water route planning for water pressure

Hydrants and sprinklers





Sprinkler system for a narrow street

Local and Government Initiative

One of the authors recognised the importance of protecting cultural heritage from post-earthquake fires after the 1995 Kobe earthquake and the Council for the Protection of Cultural Heritage from Post Earthquake Fire was established in 1997, collecting influential people from relevant fields. Two years later, a non-governmental body 'The Organisation for the Protection of Cultural Heritage from Natural Disasters' was established. In August 2001, Metropolitan Tokyo approved this organisation as a non-profit organisation.

The government of Japan organised a committee to explore the feasibility of establishing actual fire protection systems for cultural heritage from post-earthquake risks in June 2003 and this committee will make public the basic concept of protecting cultural heritage places from natural hazards. On the other hand, the local government of Kyoto examined the safety of infrastructure in the Kyoto basin against strong ground movement triggered by an inland active fault which passes through the city.

Thus, the activities in relevant fields for the protection of cultural heritage places have been gradually activated and some real-

istic proposals for a protection system are expected. Within the situation described above, the authors conducted case studies to develop a protection system for historic conservation areas. The results are to be adopted in a Japanese government project to establish a post-earthquake fire protection system in the near future.

In March 2001, the Council for Science and Technology Policy, mentioned in the beginning of this paper, made public the Science and Technology Basic Plan 2001–2005. This plan proposed emphasising major four fields such as life science, information technology, nano-technology and environmental issues. The Council identified the next four topics to be promoted and natural disaster issues were included in the suggested fields. In the Plan, the importance of protecting cultural heritage places from natural disasters is recognised for the first time in the central government's official documents.

In conjunction with this Council's report, the Ministry of Land, Infrastructure and Transport began a research and development program in the field of construction technology and three proposals were adopted. The authors proposed a project concerning the protection of historical cities from post-earthquake fires. This project will be the first research project supported by the Japanese government in the field of the protection of cultural heritage and old towns themselves.

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