

The Hanshin Awaji Great Earthquake (Hyogo Prefecture Southward Earthquake)
[On 17th January in 1995, Hanshin and Awaji district]

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The earthquake, which hit the city early in the morning, brought about great damage such as the burning and collapse of buildings in the Hanshin and Awaji region. A large number of casualties occurred, and the city functions were paralyzed for a long time. In particular, a large number of casualties were caused by the collapse of houses. Furthermore, the fires that broke out just after the earthquake increased the magnitude of the disaster, which became the largest earthquake disaster in the postwar era.

A great number of fundamental infrastructures, such as expressways, railways, harbors and lifelines, were damaged.

1. Event

Early in the morning on 17th January 1995, a M7.3 earthquake whose hypocenter was below Akashi Channel occurred and brought great damage to the Hanshin Awaji district. Over 6,400 people died and over 41,500 people were injured, and the monetary amount of the damage is estimated to have been over 9.6 trillion yen. Especially, in the region that is called the "band of the earthquake disaster" (→Figure 1, 2) located on the alluvial plain of the base of Mt. Rokkosan where a seismic intensity of 7 was registered, many old wooden houses with tiled roofs fell down, and many people who were buried under the houses died. The bridge with single pillars of Hanshin Expressway collapsed over a length of 630m (→Figure 3), and the viaduct bridges made of RC rigid frame of the Shinkansen also collapsed (→Figure 4). Part of the structure of the subway was destroyed for the first time in the world (→Figure 5). In the reclaimed land of "Port Island", the cranes in the harbor dipped due to the liquefaction of the ground (→Figure 6).

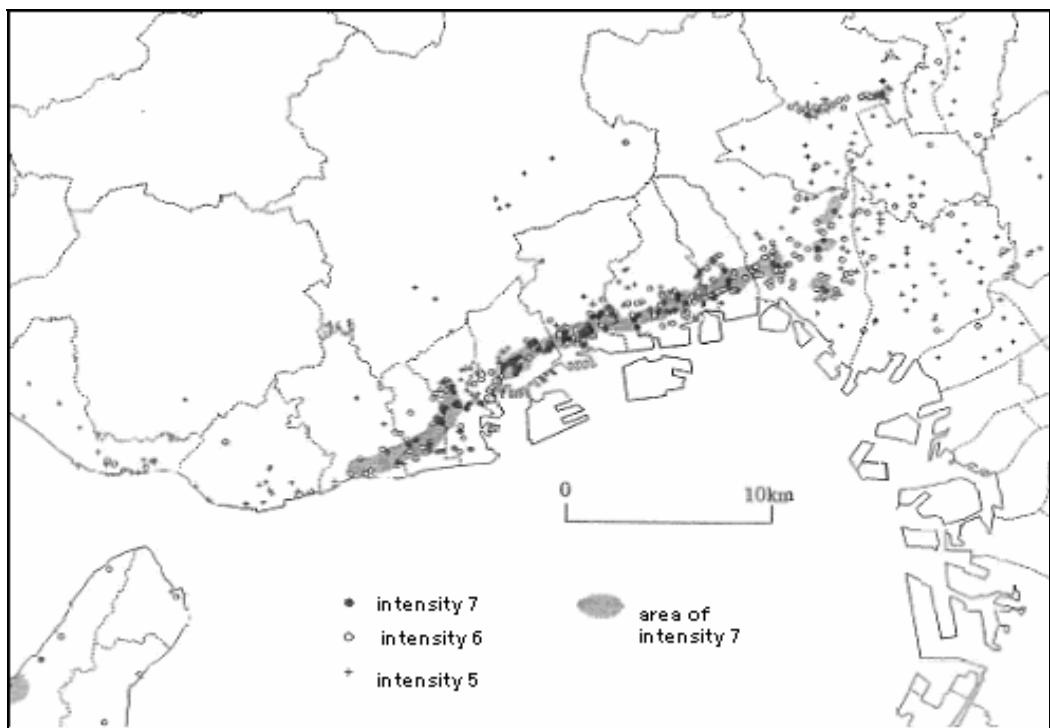


Figure 1 "The band of the earthquake disaster" in Hanshin district
(From the field study of Meteorological Agency) (Source: Architectural Institute of Japan)

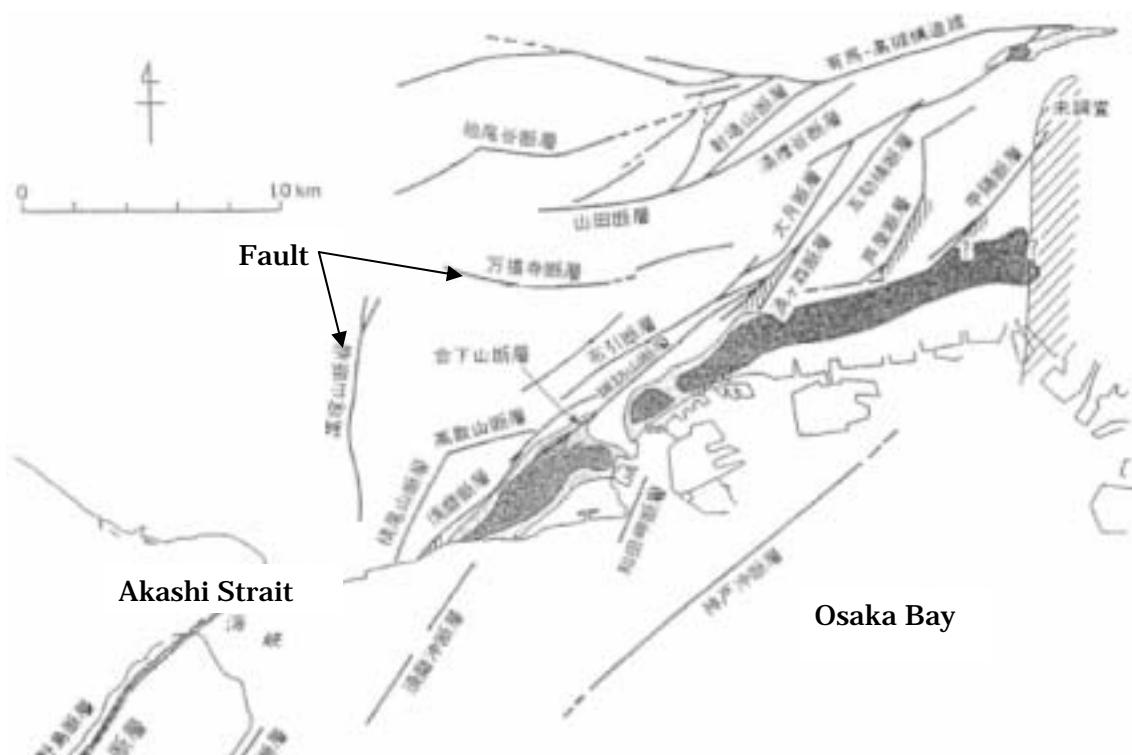


Figure 2 Fault distribution chart of Hanshin district (Source: Architectural Institute of Japan)



Figure 3 Collapse of the Pilz elevated bridge of Hanshin Expressway Kobe Line

(Source: Architectural Institute of Japan Picture: Yomiuri
Newspaper)



Figure 4 Collapse of the Hansui elevated bridge of the Sanyo Shinkansen

(Source: Architectural Institute of Japan, Picture: NikkeiBP Co)



Figure 5 Crushing of the central pillar of Daikai Station of Kobe Express Railway and collapse of the upper floor panel (Source: Architectural Institute of Japan, Picture: Prof. Iwadate)



**Figure 6: Collapse of the RC3-4 crane at Rokko Island
(Only one crane totally collapsed.)** (Source: Japan Society of Civil Engineers)

2. Course

There were four foreshocks that occurred on 16th January 1995, the night before the earthquake, with magnitudes of M3.6, M2.5, M1.5, and M2.1. These earthquakes occurred just below Akashi Channel where the main shock occurred.

At 5:46 on 17th January 1995, the M7.3 earthquake whose hypocenter was below Akashi Channel occurred. The quaking motion due to this earthquake was observed from the southern Tohoku area in the north to southern Kyushu in the south, and the seismic intensity of 7 was applied for the first time near the hypocenter. A region of seismic intensity 7, which was 1km in width and 20km in length and called the "band of the earthquake disaster", appeared from Kobe City to Nishinomiya City.

Due to the earthquake, approximately 6400 people died, about 512,880 residential houses collapsed, 285 buildings caught fire, and many infrastructures were damaged. The total amount of the damage came to over 9.6 trillion yen.

As the large earthquake occurred early in the morning, many people who were sleeping in their houses were killed due to the collapse of the house and the falling of the furniture. Furthermore, the people who did not die due to the collapse of the house could not escape since they were buried under the collapsed house, and many of them were killed by the fire.

3. Cause

Before the Hyogo Prefecture Southward Earthquake occurred, there was a general, almost superstitious, belief that "a large earthquake will not occur in the Kansai area",

although the documents for historical earthquakes prove that this belief was false. Therefore, it can be said that the consciousness of disaster prevention in the entire society of that region was low and that the disaster prevention countermeasures were not advanced.

"Many more people might have been saved, if a mechanism which stipulated that the Self-Defense Forces could be dispatched without waiting for the request of the governor had been prepared." "The damage could have been reduced if the prime minister had dealt with this situation earlier." Although a lack of the follow up measures was pointed out, the biggest reason for the large number victims caused by this earthquake was the collapse of houses, which occurred instantly after the earthquake. Of the approximately 5500 people who were killed by direct damage, 77% of them (4224 people) died from suffocation or traumatic asphyxiation, and 9.2% of them (504 people) died from burns suffered by the fires.

Autopsies of about 2400 bodies were done by the medical examiners in Hyogo Prefecture and the doctors from the Japanese Society of Legal Medicine in the localities of their responsibilities (Kobe City except for Nishi Ward and Kita Ward), and autopsies of another 1200 bodies were done by the clinicians who were asked by the Hyogo Prefectural Police. The totals for the cause of death reported on the 3651 postmortem certificates from the autopsies are shown in Table 1 (Nishimura, 1997).

Death	Number	Percentage
Suffocation	1967	53.9%
Crush	452	12.4%
Shock of injury	82	2.2%
Head	124	3.4%
Internal organ	55	1.5%
Neck	63	1.7%
Burned	444	12.2%
Insufficiency	15	0.4%
Depression/Frozen	7	0.2%
Bruise	300	8.2%
Unknown	116	3.2%
Other	26	0.7%
Sum	3651	100.0%

Table 1: The distribution of the causes of death

(Source: Architectural Institute of Japan, The report of interdisciplinary symposium on the death factors from the viewpoint of forensic medicine and casualties problems in the earthquake" (edited by Akira Nishimura / human suffering workshop, 1997)

Another report showed that 90 percent of the places where victims were injured were their own houses, including apartment buildings. The most of these victims lived in wooden houses, but not all because some RC apartment buildings also collapsed. The reconstruction of the old wooden houses had not advanced in the downtown area where

the number of victims was large. This lack of reconstruction resulted from the physical factor that there were many houses built in a terrace style making it difficult to reconstruct the houses individually the economical factor that the reconstruction costs could not paid because there were many elderly people, and the legal factor that there were many small house sites.

4. Immediate Action

As a political response to the situation, the countermeasures headquarters were established in each of the ministries concerned, the local authorities, the government corporations, and the government financial corporations.

About four hours after the earthquake, "the emergency center of Hyogo Prefecture Southward Earthquake in 1995" led by the Director-General of the National Land Agency was established by the decision of the cabinet. This center made the decision to carry out precautions against aftershocks, assessment of the damage, search and rescue operations for missing people, aid measures for the disaster victims, extinguishing of fires at the early phase, and early emergency recovery of the damaged facilities such as roads, railways and lifeline utilities.

Staff members of the fire defense authorities who gathered in the area damaged by the earthquake engaged in fire fighting and emergency rescue efforts. The total number of the volunteer fire fighters who engaged in the emergency rescue effort was estimated to be 71,000. Furthermore, many inhabitants joined self-organized disaster prevention organizations such as community associations engaged in fighting fires in the early phase, rescue efforts and preparation of hot meals.

Disaster investigating teams from academic societies such as civil engineering, architecture, earthquake, machine and geotechnology, were dispatched and investigation committees were established.

Because of the great scale of the disaster that involved many organizations, the correspondence was examined in the entire field.

5. Countermeasure

Various countermeasures were taken for restoration and reconstruction, including price stabilization measures, emergency rehabilitation, assessment and restoration of the damaged lifeline facilities, execution of the disaster garbage disposal, support for small and medium enterprises, guarantee of employment for the victims, development and improvement of the system, and so on. There are many countermeasures that are in effect even now in 2004.

6. Generalization

It is important to foresee the situation that could occur in an earthquake and to prepare appropriate countermeasures before an earthquake occurs. It goes without saying that the appropriate response after an earthquake is important, but it can be said that degree of preparation for earthquakes is the biggest factor for saving lives.

The Great Hanshin Earthquake caused such a large effect on Japanese society that it forced people to reconsider the basic social system.

In order to assure that the tremendous sufferings caused by the Kobe earthquake would result in an opportunity to create a safe and comfortable city, it is necessary to face up to the damages, to understand the problems precisely and to try to solve them.

7. Knowledge

The following lessons for the general public are mentioned.

- ◎ Training to imagine the situation that could occur in the case of earthquake
- Reinforcement of buildings should be done.
- Furniture such as sideboards should be fixed to the wall.
- It is better to sleep in the second floor when living in a detached house.

The following countermeasures are mentioned.

The protection of the lives of yourself and the people you know should be the highest priority since there is no lifesaver just after a big earthquake. It is important to foresee the situation that could occur in an earthquake and to prepare appropriate countermeasures before an earthquake occurs.

The following lessons for all the people who participate in the infrastructure investment are mentioned.

- It should be kept in mind that if you leave existing structures that do not meet the standards in a state of disrepair, even though the academic advance has revealed that that is a problem, your action could be considered to be a crime of omission. In the guidelines for "nonconformance to the standard", the buildings that had met the standards at the time when they were constructed could be legally released from the requirements of the current standards, even if the standards are revised. However, because this standard was established on a firm scientific basis, if the retroactive application of the revised standard is not taken for the existing buildings, they would remain dangerous.
- You cannot say that anything is safe "absolutely" if a big earthquake occurs. In engineering, a humble attitude towards nature is important.
- It is a duty of the specialists to enlighten the general public so that they would not

think that "vows made in a storm are forgotten in the calms".

8. Background

The general belief was that "a large earthquake will not occur in the Kansai district." Actually, it was noted that "if a large earthquake occurs, it will bring great damage" in the newspaper in previous decades, but this warning had been forgotten by the general public. To maintain countermeasures continuously against earthquakes which only occur every 10 to 100 years is difficult because it runs against basic aspects of human nature, such as "to get bored", "to forget" and "to give up." This catastrophic earthquake disaster has led to the realization that countermeasures have to be taken and maintained in order not to lose important things, however difficult that is.

There are some problems for which no countermeasures had been taken in spite of the fact that they should not be left, such as the problem of city blocks crowded with wooden dwellings. Countermeasures must be examined from a broad viewpoint that goes beyond the field of disaster prevention.

<Reference>

"The report of the Great Hanshin Earthquake -roundup edition-" (edited by Architectural Institute of Japan, 2003)

"Dictionary of the earthquake disaster prevention" (Tsuneo Okada and Kenzo Toki, 2000)

"The report of interdisciplinary symposium on the death factors from the viewpoint of forensic medicine and casualties problems in the earthquake" (edited by Akira Nishimura / human suffering workshop, 1997)

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