Doc 9071

CATASTROPHE
EVENT
BULLETIN

CARtograph

Kobe Earthquake, Japan

The most costly natural disaster in history

The earthquake of 17 January 1995 was the most devastating in Japan since the Tokyo earthquake of 1923. CARtograph's earthquake consultant *Antonios Pomonis* was in the affected area within 72 hours and collected data on more than 1000 buildings in the centre of Kobe City to assess the impact of the earthquake on building structures.

On the 17th of January 1995, at 5:46 am, Japan's sixth largest city was struck by a powerful earthquake. Thousands were killed while they slept, as houses, offices and motorways crumbled around them.

The earthquake's epicentre was in the western suburbs of the city of Kobe. The area of severe damage extended 30 km eastwards reaching the outskirts of Osaka. Two million people lived in the severely affected areas. At least 310,000 were made homeless; around 5,100 were killed and 27,000 injured. More than 100,000 buildings were damaged, about half of which are currently being demolished.

High cost

This is the most costly natural disaster ever, with damage estimates in the range of US$100 to 200 billion—equivalent to at least 3% of Japan's GDP. Few people expected Japanese buildings to suffer such high levels of damage, with the country's growing reputation for earthquake engineering and disaster preparedness.

The initial shock in Japan has now been replaced by a sense of uncertainty regarding the possible effects of the expected major earthquake in Tokyo.

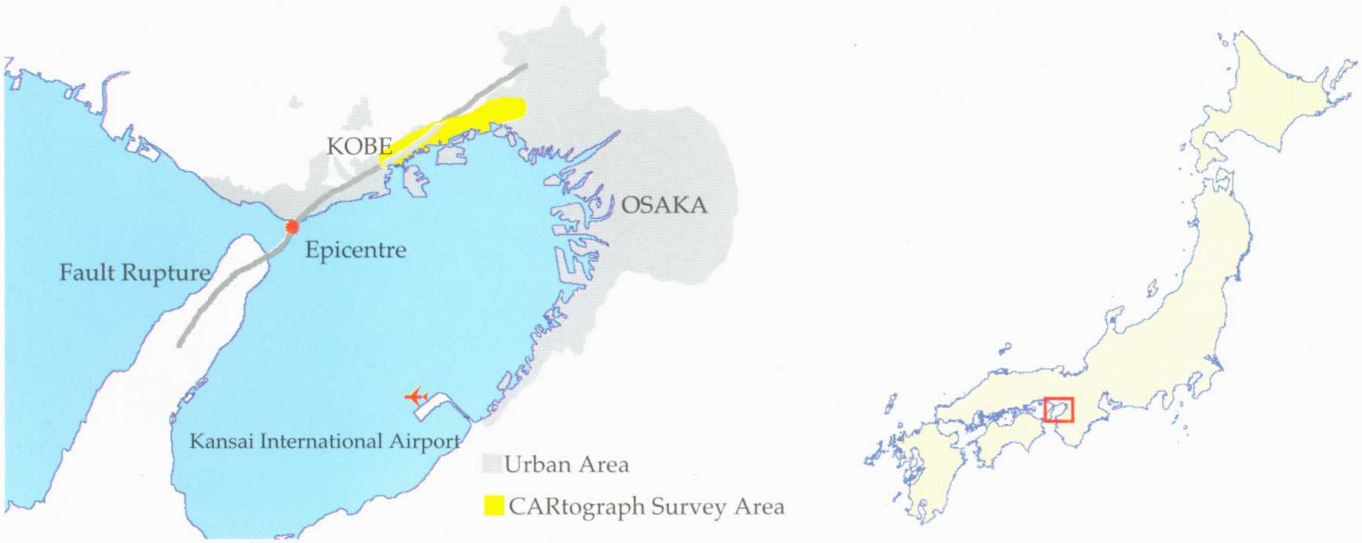
CARtograph survey

CARtograph's investigations focused on three areas in the affected region, each experiencing different levels of intensity. Over one thousand buildings were photographically surveyed, concentrating on commercial buildings in the city centre to assess damage levels and financial loss for future studies.

Observations from the field

Damage was more severe than expected. Why?

Although Japan is one of the world's most earthquake-prone countries, many were surprised by the extent of damage and loss of life in the Kobe earthquake. During the past 45 years, earthquake damage and loss of life in Japan have been limited. There was a belief that structures had been built to resist strong shaking without collapsing. The earthquake in Kobe has revealed a different picture. Buildings and other structures built before the 1981 Japanese earthquake code have been severely affected. This is partly due to the characteristics of the earthquake, but mainly due to the types of buildings affected.



Short sharp shock

Seismologists are calling this the *Great Hanshin Earthquake*. A shallow fault ruptured a distance of 30 km, generating an earthquake of magnitude 7—not massive by Japan's standards, but causing severe shaking over a localised area that happened to contain an old seaport city. Shaking up to 80% of gravity was recorded; an unusually severe shock, but lasting only tens of seconds.

Shear wall types

Hundreds of reinforced concrete office and commercial buildings collapsed or were damaged beyond repair. Many of them were reinforced concrete shear wall construction—a particular type of structure renowned for its stiffness and earthquake resistance against the majority of earthquakes more normally encountered in Japan.

Ductility deficiency

Now it appears that these buildings perform well in moderately strong shaking, but can fail disastrously when hit by a strong shock that exceeds their design limits. This lack of *ductility* in the older building stock is now being examined by the engineering community.

Newer buildings

Newer buildings fared better. Buildings designed after the introduction of the revised building code in 1981 generally survived the earthquake with much less damage. These buildings do not represent a large proportion of the building stock as most of Kobe's centre was built before 1970.

Traditional houses

The damage suffered by the traditional wooden houses (*Shinkabe* and *Okabe*) was also more severe than had been expected. The large majority of deaths was due to the collapse of these houses. The main reasons for the poor performance of these old buildings were structural deterioration, heavy roofs and weak connections in the main timber frame. Again, newer timber houses survived much better than the older building stock, but in Kobe's older quarters the traditional house was still the predominant building type.

After Kobe

The safety standards of the older existing building stock will now come under scrutiny. In areas of high earthquake risk, the lack of resistance to very strong shaking is bound to be a concern. The good performance of post-1981 buildings reaffirms confidence in the adequacy of the current design code, but the implications for the rest of the building stock will take time to be digested.