

*The CARTograph damage survey covered the city centre of Kobe, building by building. A thousand buildings were photographed and documented including comprehensive coverage of the districts of Sannomiya and Motomachi. The results of the survey will be used to re-evaluate vulnerability of Japanese buildings for loss estimation studies.*



## Damage to timber housing

Traditional wooden houses suffered the most damage and were responsible for most of the casualties. Older buildings were weakened by rotten timber, poor connections, heavy roofs, weak posts, lack of bracing and large openings.



## Urban conflagration

Ruptured gas pipes, lack of gas cut-off systems, lack of water and difficult access in densely built areas meant that a square kilometre of the city was completely destroyed by fire. More would have been lost if the wind had been stronger.



## Reinforced concrete buildings

Older buildings were more badly damaged. Many collapsed or have been condemned. Open plan office buildings and commercial buildings with large openings were the worst affected.



## Collapse of reinforced concrete buildings

The most common patterns of failure were collapse of a mid-level floor or toppling due to extreme torsional forces caused by asymmetrical designs.



## Post-1981 buildings

Reinforced concrete and steel buildings built to the revised earthquake code of 1981 suffered considerably less damage. In the case of steel structures, detailed internal investigations will be needed to see whether damage has occurred in structural joints.

## Steel and light metal frame buildings

Damage to low-rise, commercial steel frame and light metal frame buildings was severe. Poor bracing and weak cladding connections caused damage.





# Applying the knowledge

## Media Response



Dr. Robin Spence interviewed on ITN news  
17 January 1995

In the immediate aftermath of the earthquake, the project team provided specialist feedback to the media to supply early assessments of the scale of the damage. Contributions were made to a range of TV, radio, newspaper and financial news reports, including:

- ITN Television News
- BBC Radio
- Reuters International News
- New Civil Engineer
- Japan's Yomiuri Shimbun

## Project Team



**Antonios Pomonis** is a consultant to CARTograph and a director of Cambridge Architectural Research. He has 20 years of experience investigating earthquakes. He is a structural engineer with a Master's Degree in Earthquake Engineering from Hokkaido University, Japan.

*Other contributors to the study include: Dr. Andrew Coburn, Dr. Robin Spence, Janet Owers, Jonathan Platt and Sophie Brown.*

## Implications for Tokyo

*The 1923 Great Kanto earthquake caused 142,000 deaths and fires that engulfed half of Tokyo and 80% of Yokohama. It is a disaster that haunts the Japanese nation. Many seismologists believe that a severe earthquake can be expected near Tokyo in the future. What are the implications after Kobe?*

The entire Tokyo to Osaka corridor, containing about half the population of Japan and a massive concentration of investment, is at risk from strong earthquakes. Most of these earthquakes are likely to be offshore earthquakes with less severe local shaking than the rarer, shallow, inland earthquake that destroyed Kobe.

### *Weaker but longer shaking*

Predictions for Tokyo estimate ground motion at about 40%g—about half the strength recorded in Kobe. However the earthquake is likely to last longer, because its magnitude is expected to be larger, and thus will affect a much greater area.

### *Revised damage estimates*

The Kobe event shows that the older buildings are less resilient to very strong earthquakes than had previously been estimated: damage levels in parts of Tokyo could be higher than previously thought. Tokyo has far fewer old buildings than Kobe and has been



*Painting of the 1923 earthquake striking Tokyo*  
Museum of the City of Tokyo

applying stricter earthquake building codes for a longer time, so its building stock should perform better. Tokyo is also better prepared than Kobe for fires and civil emergency.

### *Higher insurance costs*

The insurance industry will bear a greater proportion of the costs in Tokyo—a much higher percentage of buildings are insured than in Kobe. Revisions of earthquake loss estimates for Tokyo are likely as a result of the Kobe earthquake.

CARTograph and its parent consultancy company, Cambridge Architectural Research, have their origins in the University of Cambridge and for many years have investigated earthquakes to build up data on damage levels to buildings. They have established an international reputation as leading researchers into loss estimation for earthquakes, and maintain a vulnerability database of over 100,000 buildings.

### *Other Earthquake Field Studies*

Bucharest, Romania, 1977	San Francisco, USA, 1989
Campania, Italy, 1980	Newcastle, Australia, 1989
Corinth, Greece, 1981	Vrancea, Romania, 1990
Dharmar, Yemen, 1982	Manjil, Iran, 1990
Erzurum, Turkey, 1983	Luzon, Philippines, 1990
Mexico City, 1985	Erzincan, Turkey 1992
Kalamata, Greece, 1986	Roermond, Holland, 1992
Armenia, USSR, 1988	Okushiri, Japan, 1993

### *Publications include:*

**Earthquake Protection**, A.W. Coburn and R.J.S. Spence, 1992, John Wiley & Sons. ISBN 0471 91833 4

**Earthquake Hazard and Risk in the UK**, (With Ove Arup and Partners), 1993, Department of the Environment, HMSO. ISBN 0 11 752773 4