Special feature: Are its lessons being adequately applied? Follow-up on the ten-year anniversary of the Hanshin-Awaji Earthquake

- Introduction -

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Ten years have elapsed since the Hanshin-Awaji (Kobe) Earthquake. Early in the morning on Monday, January 17, 1995, a magnitude 7.3 inland earthquake suddenly struck the sleeping city of Kobe. Although the severe earthquake only lasted for about 10 seconds, it destroyed 105,000 homes in an area extending from northern Awaji Island to Takarazuka, and 4,224 persons were crushed to death in their homes. Fires broke out in 290 locations, and 504 persons were burned to death, unable to escape from their collapsed homes.

In the central part of the affected region, piers were washed out to sea. Railroad bridges collapsed in various locations, leaving the ends of railroad tracks hanging in midair. Many modern buildings and expressways were knocked aslant, and some of them collapsed. One expressway collapsed for a continuous stretch of 635 meters, and this became a symbol of the failure of the "safety myth." The reputation of civil engineering technology was tarnished.

Aghast at the magnitude of the damage, many civil engineers scrambled to take emergency steps for safety and transportation, starting that same morning. One engineer who was living in Kobe was shaken awake by the strong earthquake. He says that he instinctively realized the seriousness of the situation, so he immediately divided up all the cash on hand between himself and his family and headed to work, where he stayed and kept working for one week straight.

The Japan Society of Civil Engineers immediately formed survey teams and conducted four on-site surveys involving about 100 persons related to JSCE. The survey results were reported to a total of 11,000 persons at 18 institutions nationwide. Fourteen JSCE committees also formed subcommittees or working groups to survey the damage and determine the causes, and several conferences and symposia were held. Four related academic societies jointly prepared and published a 10,000-page report which presents the accumulated knowledge and survey data.

Special committees were also formed within JSCE. Its council for the study of earthquake resistance standards and other basic problems, composed of expert members, met repeatedly for serious discussions from two months to one year after the earthquake, and issued two proposals. The special study committee on the engineering response to the Hanshin-Awaji Earthquake, composed primarily of hands-on engineers from the private sector, issued a statement concerning measures to deal with practical problems.

The basic message of the proposals was that the scope of analysis should be extended to include the processes of structural damage, assuming very strong earthquake forces of the kind that only occur

rarely; and that design methods should ensure the necessary level of safety on this basis. For more detailed information, please refer to Chapter 4.

Before the Hanshin-Awaji Earthquake, most civil engineering facilities were designed using a method based on earthquake intensity, in which the stress from a horizontal force equal to about 0.2 times the structure's own weight is calculated, and safety is verified in terms of the allowable stress. Based on the safety margins and so on, these structures were believed to be safe even in the case of an earthquake which is about twice the design seismic force. However, the Hanshin-Awaji Earthquake was far greater than twice the design seismic force.

Therefore, design methods are now used which control the failure mode to maintain a minimum level of performance in the case of strong earthquakes which are rare but conceivable (Level 2 seismic force) even if the structure enters the failure process, by avoiding modes such as shear failure or buckling which would lead to a sudden total collapse.

However, design techniques that control damage in concrete structures have only been established to a limited extent. After the earthquake disaster, vigorous research and development efforts were begun with regard to steel structures and earth structures with foundations, and the results are gradually being incorporated into design standards and the like. Meanwhile, advances are being made in technologies for seismic isolation and damping to control the actual responses of structures, and seismic isolation is now becoming more widespread.

One of the goals of this special feature is to give an overall review of the efforts that were prompted by the earthquake disaster. The Niigata Chuetsu Earthquake occurred recently, the first earthquake since the Hanshin-Awaji Earthquake to have an intensity of 7. It is still too early to review the damage from this earthquake, but the reality of tremendous damage in mountain villages definitely raises questions about the pursuit of specific actions toward the proposal recommendations for promoting earthquake-resistant reinforcement, building social systems to contribute to emergency response, restoration and recovery, and forming a national consensus on the level of investment in disaster prevention and the level of risk tolerance.

Damage and restoration of major infrastructure

	Quantity damaged	Direct damage (billion yen)	Days to restoration	Total manpower for restoration (thousand persons)
Water supply	1.29 million households	568	90	71
Sewers	23,000 locations	748	135	
Electric power	2.6 million instances	2,300	6	39
Gas lines	857,000 households	1,900	85	720
Commu- nications	285,000 lines	300	14	108
Express-ways	48 locations	3,345	623	2,500**
Railroads	32 bridges	Shinkansen: 350	Shinkansen: 81	
	3,428 elevated road columns	All lines: 3,779	All lines: 219	
Harbors	165 berths*	5,717*	730*	2,630***

Sources:
Items without asterisks were taken from the Joint Survey Report by Four Societies on Damage from the Hanshin-Awaji Earthquake.
* Kobe Port Restoration Report, Third District Port Construction Bureau, Ministry of Transport.
** Relates only to Hanshin Expressway Company (materials issued by that company).
*** *Osaka Kensetsu Kogyo Shimbun* (Osaka Construction Industry Newspaper)