



## **MEASURES AGAINST EARTHQUAKES AND FUTURE PLANS ON THE STRUCTURES BASED ON "THE SHIZUOKA PREF. ACTION PROGRAM AGAINST EARTHQUAKES"**

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### **SUMMARY**

Shizuoka prefecture is located at the center of the Japanese seismic archipelago, and it is predicted that a Tokai Earthquake and South Kanagawa Earthquake are impending. While the Shizuoka prefectural government has been working on earthquake preparedness since 1976, the Great Hanshin-Awaji Earthquake occurred on January 17, 1995. Based on plenty of precious information from the earthquake, the government set up "The Shizuoka Pref. Action Program Against Earthquakes" on May 17, 1995 and entirely reviewed the current earthquake preparedness system .

This paper reports the earthquake preparedness for buildings which was practiced based on the Program, and it suggests future tasks to be worked on for further replenishment of the preparedness.

### **INTRODUCTION**

Based on the information collected from the Great Hanshin-Awaji Earthquake, the Shizuoka Prefectural Government comprehensively examined the current disaster preparedness system and entirely reviewed it. The government adopted the following basic policies for the Shizuoka Earthquake Preparedness 300-day Action Program and announced them to the public on May 15, 1995:

- (1) Urgent matters are practiced right away, and they are budgeted if necessary.
- (2) In principle, intangible and urgent matters are practiced in 300 days .
- (3) Matters which need a revision of nationwide systems, discussion with other prefectural governments, or time-taking discussion of budgeting due to the scale of system, are oriented in 300 days and are carried out systematically according to yearly plans.
- (4) Citizens and voluntary disaster prevention organizations are instructed to set up their own plans to "protect their lives and community by themselves".

### **THE DAMAGE IN TOKAI EARTHQUAKE EXPECTED FROM THE DAMAGE IN THE GREAT HANSHIN-AWAJI EARTHQUAKE**

In the Great Hanshin-Awaji Earthquake, collapsed houses and falling furniture pressed many victims to death, and first-aid operations were delayed due to ubiquitous fire and disrupted traffic network. Collapsed buildings

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and damaged fixture also made civil businesses operation difficult, and a similar scale damage is expected in a Tokai Earthquake.

**Table-1**

	<b>Great Hanshin-Awaji Earthquake</b>	<b>Tokai Earthquake (estimated)</b>
<b>Population in prefecture</b>	5,466,000	3,686,000
<b>Richter scale</b>	7.2	8.0
<b>Area of the scale</b>	Approx. 30km <sup>2</sup>	Approx. 100km <sup>2</sup>
<b>Deaths or injuries</b>	Approx. 47,000	Approx. 94,000
<b>Collapsed buildings (including seriously and slightly damaged)</b>	Approx. 210,000	Approx. 450,000
<b>Victims of tidal wave</b>	None	Approx. 500 deaths

## RESULTS

The building-related matters in the Shizuoka Earthquake Preparedness Action Program are as follows:

### Measures taken to protect buildings

The Great Hanshin-Awaji Earthquake recorded the seismic intensity 7 and many buildings collapsed. Most of them are old wooden houses which were constructed according to the former architectural standard. The collapsed buildings, falling bill boards and exteriors hampered the traffic on roads which delayed fire-extinguishing and life-saving emergency operations. There were some damages in public buildings such as police stations, medical facilities and fire fighting bases, which also affected the operations.

In view of all these, the government has been promoting the structural reinforcement of the buildings which take an important part of disaster operations and also houses which the living of citizens is based on.

### *Promotion of reinforcement of public buildings*

#### (1) Examination of earthquake-resistance of prefectural buildings

The following table shows the results of examinations which were practiced to prefectural buildings such as schools, hospitals, welfare facilities, police stations, other government agencies for the period from 1995 to 1997:

**Table-2: (RC-class buildings)**

<b>Rank</b>	<b>Results</b>	<b>No. of buildings</b>	<b>Percentages (%)</b>
<b>A</b>	Earthquake-resistive	82	17
<b>B</b>	Further examination is needed	59	12
<b>C</b>	Reinforcement is needed	140	28
<b>D</b>	Reinforcement is needed immediately.	135	27
<b>E</b>	Rebuilding is needed.	77	16
<b>Total</b>		493	100

#### (2) Earthquake-resistive reinforcement provided to public buildings

The needs for earthquake-resistive reinforcement or the emergency of the reinforcement were judged based on the results of the examination. The government prioritized the reinforcement of the buildings which fall in the rank C and D and the rebuilding of those in the rank E.

The reinforcement is remained in the degree that the reinforced buildings will be reusable by a minimum repair service even after a large scale earthquake. This is aimed at securing not only human lives but function of the

buildings as well.

A popular reinforcement using steel braces is as follows: A window and the wall under the window are temporarily removed, and steel braces are provided just like a strut. If a building which is needed for reinforcement is under use, the braces may be provided outside the building.

Earthquake-resistive reinforcement is carried out by the prefectural and municipal governments as seen in the table-3.

**Table-3: Earthquake-resistive reinforcement by the prefectural and municipal governments (as of March 1999).**

Owned by	R C	S	SRC	W	Total
Prefecture	109	5	0	0	114
Municipalities	606	33	2	34	675
<b>Total</b>	715	38	2	34	789

As of March 1999, the earthquake-resistive reinforcement including rebuilding has been finished to 59% of the target buildings.

***Education to promote the reinforcement of private houses***

To secure a sufficient wall area in new houses, the government obligated constructors to submit wall area calculation sheets upon the application for construction permit. For the existing houses, the government offers seminars in which a booklet "Earthquake-resistance Diagnosis and Reinforcement of Your House", video tapes "Earthquake-resistance Diagnosis of Your House" and "Wooden Houses Resistive to Earthquake" are used to promote the citizens' awareness of earthquake-resistance and reinforcement of their houses. Request for such seminars is accepted in branch offices of local governments and the staff are dispatched to the location to make pre-arrangement for seminars.

Currently, there are 1.1 million wooden houses in the prefecture. Among these houses, 600 thousand houses (equivalent to 55% of the total) are judged as resistive to earthquake.

***Examination and reinforcement of the buildings alongside emergency transportation and evacuation roads***

The prefectural and municipal governments examined the buildings with more than 2 stories and block fences which are built alongside emergency transportation or evacuation roads. The examination was practiced for the period from April 1995 to March 1997 and they are totaled to 14,474 cases. From April 1997, based on the examination, the governments started to contact or send a direct mail to the building owners to instruct reinforcement of their properties.

Among these buildings, 7,368 of them were built in compliance with the former architectural standard. Further, 923 out of the 7,368 buildings have been finished with earthquake-resistive reinforcement. After all, the number of buildings which are confirmed as resistive to earthquake is counted to 8,029, which is equivalent to 55% of the total.

**Table-4: Status of reinforcement of existing buildings alongside emergency transportation roads (as of March 1999)**

	Cases	Buildings of former standard	No. of reinforced buildings.
Diagnosed	14,474	7,368	1,387
Reinforced			923
Exteriors, air conditioners, and falling materials.		3,533	635
<b>Block fences</b>	11,692	5,564	932

### Damaged building emergency inspectors

In the Great Hanshin-Awaji Earthquake, damaged building emergency inspectors officially dispatched to the site and practiced their duties for the first time in Japan. 109 inspectors were from Shizuoka prefecture, but they could not perform their duty sufficiently because more inspectors were needed to fulfill the operation.

**Table-5: Inspectors dispatched to the site in the Great Hanshin-Awaji Earthquake**

Period of operation	Staff from prefectural gov't	Staff from city gov't	Civilian architects	Total
January 18, 1995 to February 10, 1995	41	28	40	109

Reflecting the foregoing, the government keeps recruiting and training damaged building emergency inspectors to secure the necessary number of inspectors and using efforts for more organized inspection system. The major action plans for that are as follows:

#### *Recruiting and training of damaged building emergency inspectors*

To recruit, train and register inspectors who are capable to inspect and judge the status of many damaged buildings in a short period, seminars are offered.

(1) Seminars and registered inspectors

**Table-6: The number of registered inspectors (as of March 1999)**

Frequency of seminars	Participants in seminars	Registered inspectors
60 times	8,242	7,780

(2) Seminars for registered inspectors to renew registration

**Table-7: Seminars for registered inspectors**

Year	Frequency (times in the year)	Participants
1996	12	893
1997	14	1,341
1998	9	737
Total	35	2,971

#### *Fulfillment of a nationwide support system*

To realize a speedy and accurate inspection of damaged buildings, the inspection method and mutual support system were adjusted to be more agreeable over administrative divisions in Japan. For the purpose to streamline the practical operation system, the National Damaged Building Emergency Inspection Council was established on April 5, 1996. In January 1999, based on a drill model made by the Council, the communication between

administrations including mutual requests for support was practiced.

### ***Manuals of damaged building emergency inspection and procurement of materials***

While the National Damaged Building Emergency Inspection Council is in process of making a complete manual of damaged building emergency inspection in 1999, local governments plot to procure materials necessary for the operation of damaged building emergency inspection. The Shizuoka prefectural government has been instructing the local municipal governments to procure and arrange materials necessary for damaged building emergency inspection, and 29 out of 54 municipalities have already finished it.

## **FUTURE TASKS**

### **Earthquake preparedness for buildings**

(1) The public buildings will be an important base for the disaster operation once a Tokai Earthquake hits the prefecture, therefore, the reinforcement of public buildings is prioritized depending on fragility of the structure and emergency in usage.

(2) Most of the deaths in the Great Hanshin-Awaji Earthquake were caused by the pressure underneath collapsed buildings. To minimize such deaths in private houses, reinforcement or rebuilding is indispensable. However, there are two reasons why the reinforcement of wooden houses is not promoted quickly, that is: (a) Unlike the cosmetic renovation, "the reinforcement spoils the appearance of window arrangement and impairs the convenience of use". (b) It is costly, and "I would rather leave my house as it is, because there is no point in spending money to make my house inconvenient".

To deal with these grievances, the government needs to look into more affordable reinforcement methods which have been developed by private business entities since the Great Hanshin-Awaji Earthquake and it also needs to provide incentives to advance the development in order to offer more reasonable reinforcement service to citizens in the prefecture.

(3) The institution of subsidy for earthquake-resistance examination and reinforcement of buildings and structures which are built alongside emergency transportation or evacuation roads is more replenished in April 1999. From now on, the government needs to promote earthquake-resistive reinforcement, announcing and utilizing the institution.

### **Damaged building emergency inspectors**

(1) Estimated from the scale of a predicted Tokai Earthquake, the number of necessary damaged building emergency inspectors will be about 5,000. Taking into consideration the inspectors who are actually victimized in the disaster, the number will be 10,000.

(2) A further study and discussion are needed in the National Damaged Building Emergency Inspection Council for the cost of inspection, the compensation for injury or death of inspectors, control of operation, foods and accommodations, and so on. To clarify and define the position of inspectors, a legislation may be needed, too.

(3) Once an earthquake occurs, each municipal government needs to perform the inspection by themselves to secure evacuation space in their public buildings. In this end, the prefectural government instructs such municipalities to prepare materials which makes the emergency inspection possible, if they are not ready yet

## **CONCLUSIONS**

The Shizuoka prefectural government has been working on a comprehensive earthquake preparedness system, but the scope is too vast to cover all measures both before and after occurrence of earthquake, and the perfection would not be fulfilled in any future. But, the most important thing is that the citizens and administrations work as a united body based on the basic rule, "Protect One's Life by Oneself" in order to minimize the loss and damage of human lives, social assets, environments, cultural properties and whatsoever in a predicted large scale earthquake.