



## TOKAI EARTHQUAKE PREPAREDNESS PROGRAM " TOKAI-ZERO" IN SHIZUOKA PREFECTURE , JAPAN

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### Summary

In the Pacific Coast of the Japan islands, the subducting plates lead to repeated earthquakes. Shizuoka prefecture is located in the Tokai region, about 150 km south-west from Tokyo, Japan. The Nankai trough runs off the coast of the prefecture and it has repeatedly caused major earthquakes with an average return period of 100 to 150 years.

Since the last major event, the 1854 Ansei Tokai Earthquake, occurred along the trough about 150 years ago, the next big one with Richter magnitude of 8.0 is predicted to occur in the near future. Furthermore, abnormalities in the fluctuation of the earth's crust has been observed in SurugaBay area, and the disaster mitigation against the next Tokai earthquake is one of the major issues in the Toukai region.

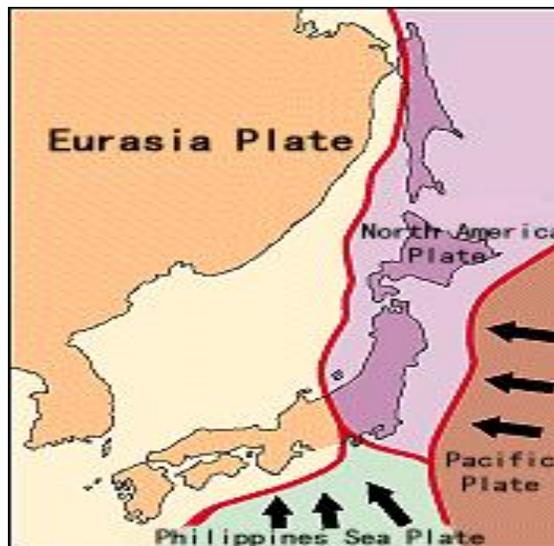


Figure 1 A motion of Philippines Sea Plate and Pacific Plate

<sup>1</sup> Shizuoka Prefectural Government , Japan

Shizuoka Prefecture estimates the damages of the Tokai Earthquake will be a magnitude 8 on the Richter scale. An estimation of death predicts 5,900 persons, those to be seriously injured estimated at 18,700 persons, those to be moderately injured is estimated at 85,700 persons in a worst case scenario. Further, the structural damages will be about 750,000 buildings half of all building in Shizuoka Prefecture.

This paper shows the “TOKAI—ZERO” project focusing on the background policy, socio-economic issues as well as seismological observation results, and the effectiveness of the disaster mitigation project is discussed based on the statistical data.

### **Introduction**

Project “TOKAI—ZERO” is one of top key policies positioned as Category 1 among 32 priority actions in “Anti-earthquake Measures Action Program 2001”.

Seismic Reinforcement Promotion Program for Wooden House founded in FY2002 is one of the few programs, newly admitted under the prefectural severe fiscal circumstances. Therefore, this project is a top priority of Shizuoka Prefecture.

### **Earthquake Resisting Strengthening of Wooden Houses**

There were 6,400 fatalities in the Hanshin-Awaji Earthquake of 1995, of which 84% of all casualties resulted from collapsed houses and fallen furniture while people were inside their houses. Under the prompting circumstance of recent seismic activities, imminence of the Tokai Earthquake has been realized and the project “TOKAI—ZERO” was started to prevent fatalities caused by collapsing houses.

This project promotes earthquake resisting reinforcement of wooden houses built under the old building codes, before 1981, and provides for the safety of residents in the event of a disaster. (Tokai is the regional name, but its pronunciation implies the word "collapse" in Japanese. )



Photo 1 Collapsed houses in Hanshin-Awaji Earthquake



Photo 2 Collapsed houses in Hanshin-Awaji Earthquake

### **Outline of Project “TOKAI—ZERO”**

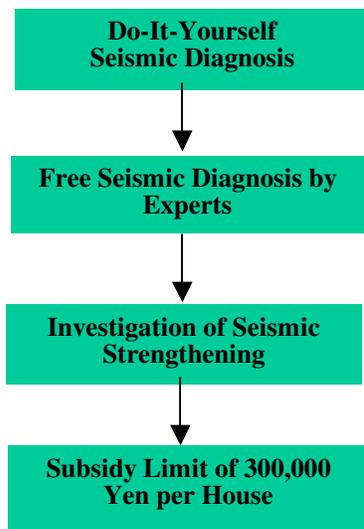


Figure 2 Flow Diagram

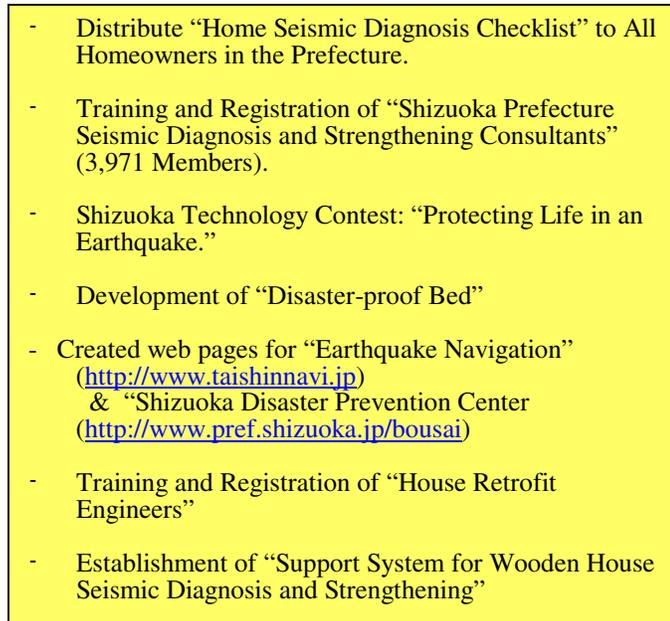


Figure 3 Outline

### (1) Eligible Houses

Approximately 600,000 wooden houses built by the traditional Japanese building technique according to the building codes before 1981 (referred to as "Old Building Code" hereafter). Such houses experienced tremendous damage in the Hanshin-Awaji Earthquake.

### (2) Simplified Seismic Diagnosis for Houses. (Shizuoka Prefecture Publication)

In 2001, the "Home Seismic Diagnosis Checklist" was distributed to all households so that homeowners can perform a simplified diagnosis by themselves, and the forms were collected in every municipality by the local disaster prevention organizations. A similar program was carried out in 2002.

### (3) Diagnosis of Homes by Experts (Shizuoka Prefecture Publication)

#### 1. Training and Registration of "Shizuoka Prefecture Seismic Diagnosis and Strengthening Consultants"

In 2001, training courses for precision diagnosis was held for first and second degree wooden architects and carpenters with at least 7 years of experience. They were instructed on how to perform precision diagnosis as experts, and they became registered as "Shizuoka Prefecture Seismic Diagnosis and Strengthening Reinforcement Consultants." Similar courses were held in 2002, and there is now a total of 3,971 registered experts.

#### 2. Diagnosis of Homes by Experts (Free Charge)

In the Simplified Seismic Diagnosis, homeowners with houses that could not assure safety (less than 1.5 total points in the evaluation) could request a detailed diagnosis by an expert. Through the consultant program mentioned above, 10,293 experts were dispatched in 2001 to perform

diagnosis and gave advice on seismic reinforcement methods. The program is planned to continue for 2002 and after.

The diagnosis of homes by experts was subsidized by the Ministry of Land, Infrastructure and Transportation's "Public Housing Promotion Council," making the evaluation free of charge. (Expenses were covered by national (1/2), prefectural (3/8) and municipal (1/8) governments, respectively.)

#### (4) Subsidy System for Strengthening of Wooden Houses

##### 1. Subsidy for Seismic Strengthening

Houses that obtained less than 0.7 points by the expert diagnosis were eligible to receive a subsidy. Shizuoka Prefecture provided 300,000 yen to the municipalities to strengthen the house to be over 1.0 in the evaluation.



Photo 3 Construction For Strengthening



Photo 4 Construction For Strengthening

##### 2. Support for Rebuilding Houses

Some houses that obtained less than 0.7 points were eligible to receive support for rebuilding. In this program, loans from private financial institutions were subsidized by reducing the loan interest by the difference between the loan rates of the private financial institution and the government disaster relief housing loan. This program was started in 2002, and the 2003 budget is for the support of 2,000 houses.

#### **Other Actions for Business Promotion**

##### (1) Fastening of Furniture

In addition to making houses earthquake-proof, measures are being taken to promote the fastening of furniture because the cause of death for 84% of the Hanshin-Awaji Earthquake victims was the collapse of houses and falling furniture. According to the Tokai Earthquake Consciousness Survey, about 54% of the citizens said they fastened either most or part of their furniture.

(2) Technology Contest 2001: “Protecting Life in Earthquakes”

A national contest was held in 2001 in order to increase the options of earthquake-proof devices in homes. The contest generated ideas for seismic strengthening construction methods of low cost housing, and also disaster proof furniture for protecting life and providing safety. The superior ideas and products are introduced in a pamphlet that is used for public relations.



Figure 4

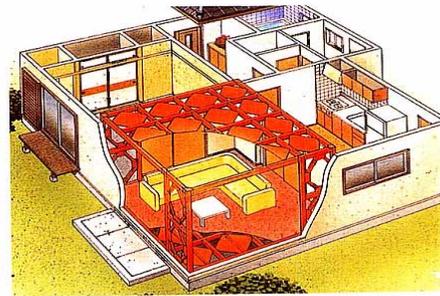


Figure 5

New Seismic Strengthening Construction Methods

In 2002, Shizuoka Prefecture developed the earthquake-proof bed together with a private company as an alternative method for people who can not afford the expense of seismic strengthening .

The purpose of the bed is to protect people sleeping on the first floor of houses under the old building codes before 1981. In order to increase the use of the earthquake-proof bed, the prefecture’s earthquake support funds will be used by municipalities to help resident purchase the bed.

In the case that the house collapses during an earthquake, the bed provides a safe space and protects the lives of people while sleeping.



Photo 5 Earthquake-proof Bed.

## Simplified Seismic Diagnosis for Houses and Free Seismic Diagnosis by Experts

In 2001, the "Home Seismic Diagnosis Checklist" was distributed to all households so that homeowners could perform simplified seismic diagnosis by themselves, and the forms were collected in every municipality by Community-based Organizations for Disaster Prevention. A similar program was carried out in 2002.

Owners who could not assure safety of their house (less than 1.5 total points in the evaluation) through the simplified seismic diagnosis could request a precision diagnosis by an expert. Experts are first and second degree architects and carpenters with at least 7 years of experience. They were instructed on how to perform precision diagnosis as experts, and they are registered as "Shizuoka Prefecture Seismic Diagnosis and Strengthening Consultants". Through the consultant program mentioned above, about 30,000 experts were dispatched for 2001 through 2003 to perform diagnosis and give advice on seismic strengthening methods. The program is planned for 2001 through 2005, with a target of 200,000 homes.

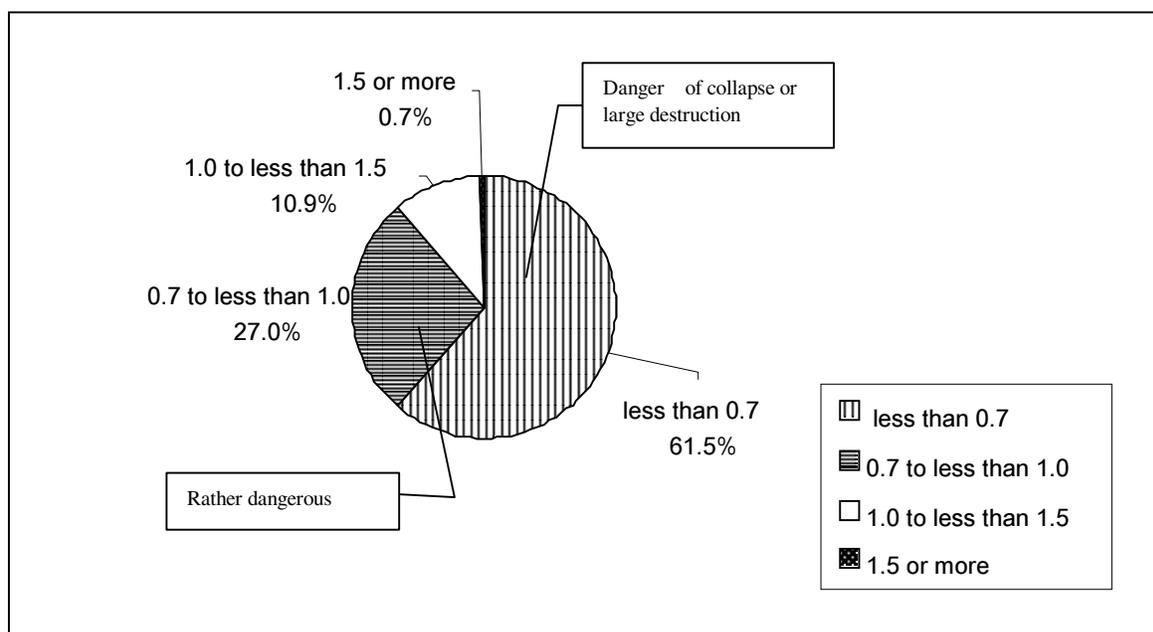


Figure 6 Home Seismic Diagnosis by Experts in 2001-2002  
: Percentage According to Points

Percentage of persons  
subject to aid

Present: 61.5%

(Less than 0.7)

Upgrading idea: 88.5%

(Less than 1.0)

\*Since about 80% of houses consulted by Home Seismic Diagnosis by Experts have quakeproof problems, the upgrading of the system is examined.

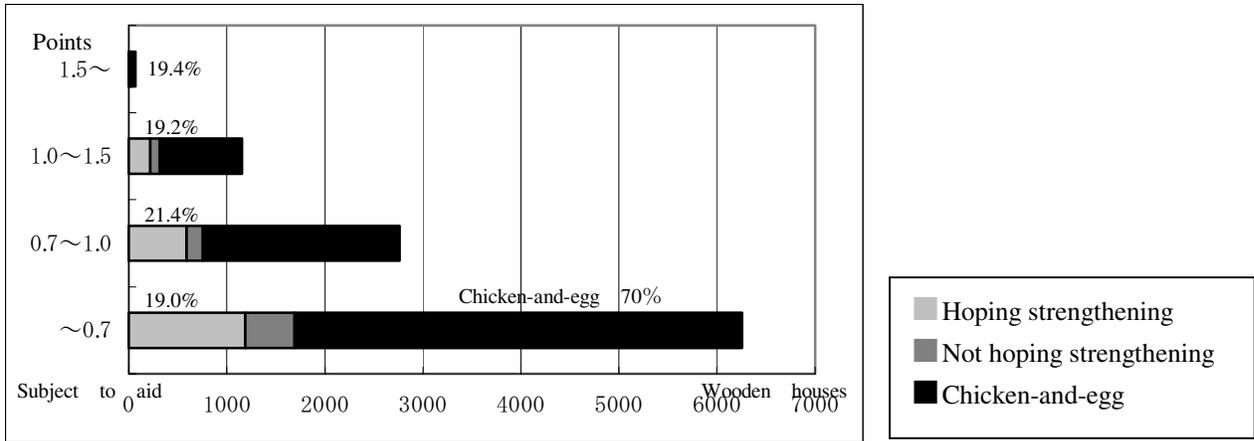


Figure 7 Results of Home Seismic Diagnosis by Experts in 2001

**Hoping strengthening +15%**

In 2001	<b>20 %</b>	7	Chicken-and-egg 73%
In 2002	<b>35 %</b>	8	Chicken-and-egg 57%

Figure 8 Change of Positive toward Strengthening 2001 -2002

### Subsidy System for Seismic Strengthening of Wooden Houses

Houses that obtained less than 0.7 points by the expert diagnosis were eligible to receive a subsidy. Shizuoka Prefecture provided 300,000 yen to the homeowner to reinforce the house to have over 1.0 point in the evaluation. Construction for seismic strengthening usually expends approximately 3,000,000 yen in Japan. The subsidy program for seismic reinforcement is planned for 2001 through 2005, with a target of 10,000 homes. Presently (the end of February, 2004), there have been 1,029 cases that received the subsidy, but this number is lower than expected.

"Earthquake-proof points 0.71" is given as an example of utilizing the subsidy of our prefecture: the required cost for the reinforcement construction is about 1.9 million yen on average and the cost would become lower than 1 million yen by adopting low-cost and simplified method. Therefore, such information is shown to the prefectural inhabitants as strengthening examples.

The earthquake-proof for house would be promoted by spreading such information. It is entirely dependent on how the prefectural inhabitants utilize this maintained system in the future. Needless to say, it is important that the inhabitants promote the earthquake measures (protect our lives by ourselves).

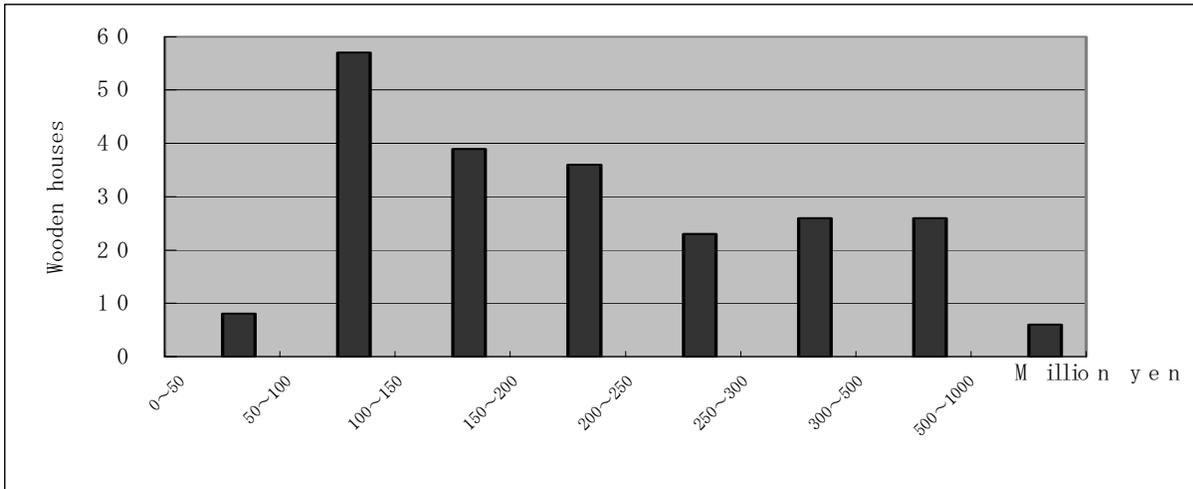


Figure 9 Construction Cost Subject to Subsidies

Percentage of construction cost

- 1) 0-1 million yen 65 (29.2%)
  - 2) 1-2 million yen 75 (33.6%)
  - 3) 2-3 million yen 49 (22.0%)
  - 4) 3-5 million yen 26 (11.7%)
  - 5) 5-10 million yen 6 (3.6%)
- 1.3 million yen or less: 86 (38.9%) → About 40% is 1 million yen or less of personal expense.

**Effectiveness of Disaster Mitigation Project**

(Reduction of earthquake reconstruction work cost and damage)

The summary of expenditure (national expenditure) for collapsed houses in Hanshin-Awaji Earthquake is as follows. Some of above items and house rebuilding are paid by the local authorities besides the national expenditure. Since low-interest loan for house rebuilding and shrinking tax revenue directly linked to house damage (including reduction and exemption of tax) are also huge, the amount of public investment is very huge.

For instance, if buildings are leveled by the earthquake in urban area, the public investment would be required 13 million yen per completely collapsed house for removing rubble, building temporary housing, building emergency restoration public housing, etc..

Since the local government has provided aid for reconstruction work, it is thought that the actual public investment was 20 million yen per completely collapsed house.

Table 1 \*Source: "In an effort to promote earthquake retrofit in densely built-up area",  
Ministry of Land, Infrastructure and Transport Housing Bureau

1) Construction of temporary housing (for about 50,000 households):	About 170 billion yen
2) Removing rubble of collapsed buildings:	About 170 billion yen
3) Payment of condolence money and loan of relief fund:	About 140 billion yen
4) Supply of emergency restoration public housings (for about 40,000 households) and support for rebuilding housing by their own expense:	About 770 billion yen
	Total About 1.2 trillion yen
(About 13 million yen per completely collapsed house)	

Since 131,000 buildings are estimated to be completely collapsed in Tokai Earthquake, if earthquake retrofit is implemented for 10,000, about 7.4% of buildings can be improved as mentioned above.

If the local government in Shizuoka invest 3.0 billion yen over respectively by introducing the earthquake retrofit aid set at this time, 65 billion yen of earthquake reconstruction work expenditure for 10,000 houses would be reduced and the investment is highly effective.

The implementation of earthquake retrofit is not only cost-effective but also controls fire damages and crushing death by collapse of buildings so it is highly effective.

### **Future Prospects, Issues and Responses**

The system including home seismic diagnosis by experts, method advisement, aid to seismic strengthening, interest subsidy to debt finance for rebuilding, organization of private builders and supplement support is now complete.

In addition, we have positively developed activities such as commercials on TV, symposiums at various places in our prefecture and enlightenments through newspapers and announcements.

As a result, prefectural inhabitants' awareness of earthquake protection has gradually increased and the percentage of inhabitants who are positive toward strengthening construction increased from 20% in FY2001 to 35% in FY2002. The future promotion can be expected according to the inhabitants' change of awareness.

For the performance of seismic strengthening, the total number of the reinforcement application is about 1,000: 254 in last year and 775 as of the end of February in 2004. There is finally a sense of earthquake retrofit for wooden houses and the future promotion is expected.

There are about 600,000 wooden houses having low earthquake protection under the old building codes in our prefecture so we would have to say that it is far too low a level compared with the target.

It has been pointed out that the Tokai Earthquake is imminent and the government has worked out support measures for Tokai Earthquake prevention. Therefore, the promotion of project "TOKAI—ZERO" is further imperative.

Our prefecture will also examine this system so that it becomes more accessible for the prefectural inhabitants.

There are also various demands from the prefectural inhabitants. Therefore, it is necessary to meet those needs of the prefectural inhabitants with cooperation between the government and private sectors; prefectures, municipal governments and private architectural engineers.

However, as it is thought from the beginning of the project, the earthquake-resistant measures for wooden house is never easy to promote. It is important to implement various promotion measures steadily one by one. Especially, in order to solve the cost problem which is a major stumbling block against earthquake retrofit, it is important to show the inhabitants practical examples of low-cost seismic strengthening concretely and compare the seismic performance after the seismic strengthening with cost for strengthening to convince them.

"Earthquake-proof points 0.71" is given as an example of utilizing the subsidy of our prefecture: the required cost for the strengthening construction is about 1.9 million yen on average and the cost would become lower than 1 million yen by adopting low-cost and simplified method. Therefore, such information is shown to the prefectural inhabitants as strengthening examples.

The earthquake-proof for house would be promoted by spreading such information. It is entirely dependent on how the prefectural inhabitants utilize this maintained system in the future. Needless to say, it is important that the inhabitants promote the earthquake measures (protect our lives by ourselves).

### **Acknowledgment and Conclusion**

This project has been supported by a lot of people such as the government, academic experts and architectural engineers from the start-up to the promotion. Especially, we wish to express our gratitude to architects in Shizuoka Prefecture for cooperation with earthquake-resistant measures such as "Home Seismic Diagnosis by Experts".

The seismic reinforcement aid system that Shizuoka Prefecture introduced is spreading nationwide now. We hope that the system is more developed, engineer development in private sectors and new product development are advanced, the earthquake retrofit is implemented for many wooden houses and the number of victims from the large earthquake becomes smaller learning from Hanshin-Awaji Earthquake.