



Tokai Earthquake Preparedness Program “TOKAI-ZERO” in Shizuoka Prefecture, Japan(part 2 Recent challenges in promoting seismic retrofit program)

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Abstract

Since 1976, Shizuoka Prefecture has carried out earthquake preparedness measures against the Tokai Earthquake in scenario. A Project “TOKAI-ZERO” launched in 2001 as a result of the 1995 Kobe Earthquake, in which more than 80% of fatalities were due to building collapse. The project aims to promote seismic retrofit of old timber houses built before 1981, which had most serious damage in the 1995 earthquake. This project focuses on (1) seismic evaluation of houses under full financial support by Shizuoka prefecture, (2) technical support for redesign of vulnerable houses, and (3) subsidies for their seismic retrofit. Approximately 18,600 seismic retrofit works were subsidized in the 13 years since FY2002. The project aims to increase the rate of the seismically-sound houses to 90% by FY2015. The rate was increased 82.4% in FY2013 from 72.9% in FY2003. Approximately 230,000 old timber houses still require seismic retrofit, and earliest possible action is desired to improve the situation.

Keywords: Tokai Earthquake, A Project “TOKAI-ZERO”, Shizuoka Prefecture

1. Introduction

There are 4 plates influencing Japan: The Pacific Plate and the Philippine Sea Plate, facing west and north north-west, respectively, extend under the Eurasian Plate and the North America Plate, on top of which the Japan Archipelago lies. Shizuoka Prefecture is uniquely located over the underground junction of these 4 plates. (Fig.1)

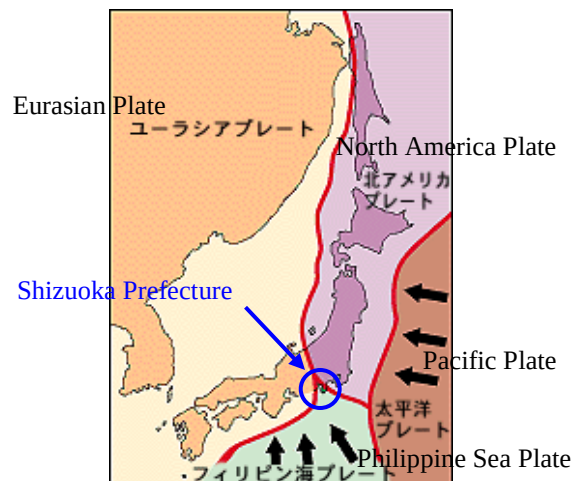


Fig.1 — Plates surrounding Japan



On the Pacific Coast of the Japan Archipelago, large scale earthquakes caused by sliding of the Philippine Sea Plate have repeatedly occurred approximately in the same area in the same scale in a cycle of about 100 to 150 years. In the western part of the Tokai Earthquake's epicenter area, it is believed that the accumulated energy was released in the 1944 Tonankai Earthquake and the 1946 Nankai Earthquake. However, it has been more than 160 years without a large earthquake in Tokai region since Ansei Tokai Earthquake in 1854, and experts predict that a Tokai Earthquake of approximate magnitude 8 will occur with the probability of 88% within the next 30 years. After the Tohoku Pacific Ocean Earthquake in 2011, experts also claim the possibility of a mega thrust earthquake, in which three earthquakes of Tokai, Tonankai and Nankai occur simultaneously.

2. OVERVIEW OF PROJECT "TOKAI-ZERO"

Basic disaster prevention is to "protect oneself." However, the death toll in Hyogo-ken Nanbu Earthquake in 1995 reached 6,434, approximately 84% of which were caused by house or building collapse and crushing from fallen furniture. To learn from this, protect the lives of residents of the prefecture from building collapse and reduce the number of deaths as close to zero as possible in Tokai earthquakes through promotion of earthquake-proofing of old wooden houses built under the old earthquake resistance standards before 1981 which comprised a large part of those that suffered damage, Shizuoka Prefecture launched "TOKAI-ZERO," a subsidy project to promote earthquake-proofing of private houses in 2001 ahead of the rest of Japan.

(TOKAI, originally a part of the name of the anticipated earthquake, also rhymes with a Japanese word for "destruction", or *tokai*.)

Shizuoka Prefecture has worked on various disaster reduction measures against Tokai earthquakes, including preparation of "Earthquake and Tsunami countermeasures Action Program" in 2001. Project "TOKAI-ZERO" is positioned as the most important measure among the key measures of this program.

The pillars of this Project are comprised of (1) "Free evaluation of seismic evaluation," (2) Subsidy for preparation of "retrofit plan" and (3) Subsidy for "seismic strengthening works" (Fig. 2).



Fig.2— Main focuses of Project "TOKAI-ZERO"

This paper focuses on Project "TOKAI-ZERO" and discusses the background, seismological observations, socioeconomic issues, and the effectiveness of the project based on the statistical data.



3. OBJECTIVE FOR SEISMIC RETROFITTING OF HOUSES IN SHIZUOKA

According to “Shizuoka Prefecture Earthquake Damage Estimation, 3rd Edition” which the Prefecture announced in 2001, the human damages from a Tokai earthquake will include 5,851 deaths in the worst case. Of this figure, 4,646, which are 80% of the total death toll, will be caused by building collapse.

In “Shizuoka Prefecture Earthquake Damage Estimation, 4th Edition” (Table 1) which was announced in 2013 after incorporating the lessons from the Tohoku Pacific Ocean Earthquake, the human damages of a major earthquake in the Nankai Trough are estimated to include approximately 105,000 deaths (of which 96,000 deaths by tsunami) in the worst case.

Table 1 – Shizuoka Prefecture Earthquake Damage Estimation, 4th Edition (2013)

Level 2 earthquake and tsunami
(a major earthquake in the Nankai Trough (Magnitude approximately 9.0))

Building damages (Case of eastern region, winter, evening, no earthquake prediction)	Number of houses collapsing completely/burning down: Approx. 300,000 Of which houses damaged due to earthquake motions/liquefaction: Approx. 190,000
Human damages (Case of land region, winter, late night, low early evacuation rate, no earthquake prediction)	Number of deaths: Approx. 105,000 Of which number caused by tsunami: Approx. 96,000

(Note) Level 2 earthquake and tsunami: Earthquake and tsunami of the largest class in which all possibilities have been taken into consideration and which will result in considerable damages, even though the frequency of occurrence is low

Since it is necessary for Shizuoka Prefecture to promote the earthquake-proofing of houses, which is the most effective measure in disaster reduction, they prepared “Shizuoka Prefecture Earthquake-Proof Retrofit Promotion Plan” in 2006 with a goal to improve the earthquake-proofing rate for houses to 90% by Fiscal 2015.

The situation of earthquake-proofing of houses in Shizuoka Prefecture in 2013 was estimated in 2013 National Housing and Land Survey (Table 2) to include 1,137,549 houses (approx. 82.4%) with earthquake-proofing and 242,851 houses (approx. 17.6%) with insufficient earthquake-proofing of the total number of 1,380,400 houses.

While the earthquake-proofing rate for houses was improved by 9.5% from 72.9% in 2003 to 82.4% in 2013 in 10 years, approximately 230,000 wooden houses which were constructed under the old earthquake resistance standards and considered to require earthquake-proofing still remain.

Based on this, the planned period for “Shizuoka Prefecture Earthquake-Proof Retrofit Promotion Plan” was extended by 5 years in 2016 with revisions to change the goal to improvement in earthquake-proofing rate for houses to 95% by the end of Fiscal 2020.



Table 2 – Seismic-soundness of houses in 2013 (Unit: houses)

Classification	Total	No. of houses built after 1982	No. of houses built before 1981	
		Seismically sound	Seismically sound	Seismically not sound
Timber houses	908,600	604,066	77,687	228,847
Non-timber houses	471,800	404,590	53,206	14,004
Total No. of houses	1,380,400		1,137,549	242,851

4. PROJECT PERFORMANCE OF “TOKAI-ZERO”

4.1 Performance of “Free Seismic Evaluation by the Expert”

House owners can apply for “Free Seismic Evaluation by the Expert” through just a call, and the municipality sends an expert. This is called “Shizuoka Prefecture Seismic Soundness Evaluator and Retrofit Consultant” and free of charge. The dispatched expert, then, assesses the seismic soundness of the house based on on-site survey and building drawings.

The evaluation is the very “first step” to raise the citizens’ awareness of the need of seismic retrofit plan and work, and it is important that as many citizens as possible have their houses evaluated. Utilizing the national subsidy system, this service is offered free of charge. A total of 73,343 houses were evaluated in a 14-year period between FY2001 and 2014. (Table 3)

Table 3 – Project performance of “TOKAI-ZERO” (Unit: houses)

Fiscal Year	Seismic Evaluation	Retrofit Plan	Retrofit Work	Additional Financial Support for the Elderly, etc.	
2001	10,293	—	—	—	—
2002	10,622	293	254	—	—
2003	8,652	1,034	807	—	—
2004	7,853	1,868	1,595	607	(38.1%)
2005	6,242	2,189	2,022	782	(38.7%)
2006	3,690	1,583	1,615	613	(38.0%)
2007	4,469	1,765	1,500	616	(41.1%)
2008	3,623	1,874	1,547	642	(41.5%)
2009	3,516	2,061	1,582	661	(41.8%)
2010	2,918	2,363	2,639	1,070	(40.5%)
2011	3,632	1,797	1,216	525	(43.2%)
2012	2,769	1,672	1,535	629	(41.0%)
2013	2,523	1,495	1,259	580	(46.1%)
2014	2,541	1,191	1,005	453	(45.1%)
Total	73,343	21,185	18,576	7,178	(38.6%)

4.2 Performance of “Retrofit Plan” and “Retrofit Work”

“Retrofit plan” includes examination of which parts should be reinforced and how they should be reinforced based on the seismic evaluation. A subsidy system for preparation of retrofit plan was launched in 2002, and the amount of subsidy remains at 2/3 of the plan preparation cost and reaches 96,000 yen/house at maximum by also utilizing the national subsidy system (in general, it costs about 150,000 yen/house for preparation of a retrofit plan, and one must pay for his/her own expense of approximately 50,000 yen). Starting in 2013, subsidy up to 144,000 yen/house as 100% or less of the plan preparation cost was began for households comprising only of the elderly. The cumulative result for 13 years from Fiscal 2002 to Fiscal 2014 reached 21,185 houses.

(Table 3)

“Seismic retrofit work” corresponds to the work to retrofit wooden houses on “Risk of collapse or major destruction” or “Slightly at risk” levels with seismic evaluation score (Table 4) being smaller than 1.0 as a result of seismic evaluation to “Safe for the present” level with score 1.0 or higher (Fig. 3 , Fig 4).

Table 4— Seismic soundness score and criteria used in the seismic evaluation

Soundness score	Criteria
1.5 or higher	Safe (The house will not collapse)
1.0 or higher, less than 1.5	Fairly safe (The house will probably won’t collapse)
0.7 or higher, less than 1.0	Fairly unsafe (The house may collapse)
Less than 0.7	There is risk of collapse or major destruction (The house is likely to collapse)

The basic amount of subsidy for seismic retrofit work for an ordinary household is 300,000 yen. The municipality adds their own subsidy amount of 100,000 to 600,000 yen to this amount. Starting in 2004, a system to provide household comprising only of the elderly aged 65 or older or households including handicapped members with additional subsidy of 200,000 yen to the subsidy amount for ordinary households was launched, extending the system to be more accessible.

The cumulative result for the 13 years from Fiscal 2002 to Fiscal 2014 was 18,576 houses (Table 3).

The average cost of seismic retrofit work for Fiscal 2014 utilizing the subsidy system of Shizuoka Prefecture was approximately 1,640,000 yen.



Fig 3— Seismic retrofit, Example 1



Fig 4— Seismic retrofit, Example 2



5. DISASTER MITIGATION EFFECTIVENESS OF PROJECT “TOKAI-ZERO”

Shizuoka Prefecture estimated in 2010 its interim result for the progress and future prospects of “Shizuoka Prefecture Earthquake and Tsunami countermeasures Action Program” (Table 5).

Thanks to the promotion of project “TOKAI-ZERO” so far, the estimated number of deaths was reduced by 1,521 from 5,851 to 4,330 at the end of Fiscal 2008. Project “TOKAI-ZERO” will deliver a great disaster reduction effect as a measure against Tokai earthquakes.

Table. 5— Estimated reduction of fatalities (by the cause of death)

(Unit: persons)

Classification Cause of Death	Estimated fatality based on the 2001 Earthquake Damage Estimation, 3 rd Edition	Estimated fatality after implementing Action Program 2001 by the end of FY2005	Estimated fatality after implementing Anti-earthquake Measures established by end of FY2008
Building collapse, etc.	4,822 (Estimated reduction)	3,930 (△892)	3,547 (△1,275)
Building collapse	4,646	3,759	3,384
Interior structures	176	171	163
Tsunami	227	196	102
Landslide	555	516	500
Fire	117	95	87
Other	130	94	94
Total	5,851 (Estimated reduction)	4,831 (△1,020)	4,330 (△1,521)

6. CHALLENGES AND FUTURE COURSE OF PROJECT “TOKAI-ZERO”

6.1 Challenges and future course of “Free Seismic Evaluation by the Expert”

Shizuoka Prefecture have taken measures in the past to promote earthquake-proofing of houses through various opportunities and media, including public relations magazines of Prefecture and municipalities, TV and radio broadcasts, brochure distribution, direct mails, door-to-door visits, lecture meetings, consultation meetings and disaster prevention events.

According to “2015 Prefectural Residents Consciousness Investigation on Tokai Earthquakes” conducted by Shizuoka Prefecture, the most frequent reason for not having seismic evaluation done (Fig. 5) was “too expensive” at 44.0%, followed by “damages from large earthquakes happen anyway even if we have evaluation” at 32.8% and “it is too troublesome” at 27.6%.

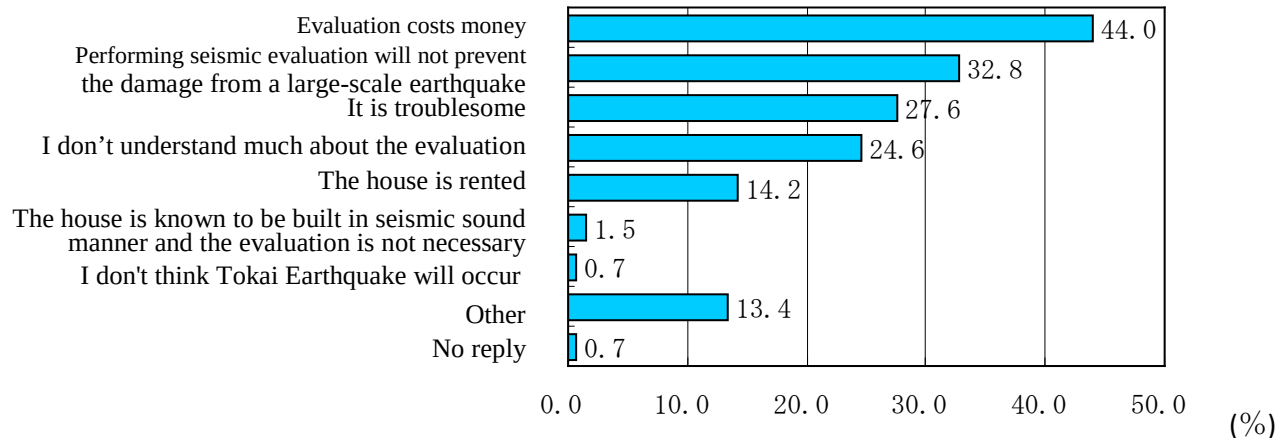


Fig. 5— Shizuoka citizens' awareness survey on Tokai Earthquake in 2015:
“Why have you not performed the seismic evaluation?”

It seems that the owners of old houses are somewhat aware of the fact that the houses they live in may have low earthquake-proof performance. By carrying out the seismic evaluation, it is expected to face financial problems such as expenses for seismic retrofit work or rebuilding. For these reasons, it can be considered that they are reluctant to carry out the seismic evaluation. It is a great challenge how such people can be encouraged regarding the necessity of earthquake-proofing of houses as a measure.

The measures so far have revealed that it was effective to directly approach the owners of the corresponding houses and convince them of the necessity for earthquake-proofing the houses. Based on this, Shizuoka Prefecture has been working on direct approaches with focus, including direct mails with return postcards for application of seismic evaluation and easy-to-understand explanation during door-to-door visits.

6.2 Current issue and future course of “Retrofit Plan” and “Retrofit Work”

Concerns and worries about the construction expenses are large factors that make people hesitate to make retrofit plans or start seismic retrofit works.

People who have had seismic evaluation done and experts on earthquake-proofing of houses say “up to 1 million yen would be an amount they can pay for retrofit work.” The number of houses by the amount of seismic retrofit work expense in Fiscal 2014 (Fig. 6) also shows that more than half of the houses set the total amount of seismic retrofit work expenses to be 1.5 million yen or lower and their financial burden to be 1 million yen or lower. Based on this, it is assumed that many people will decide to have seismic retrofit work if their financial burden related to the work is limited to 1 million yen or lower.

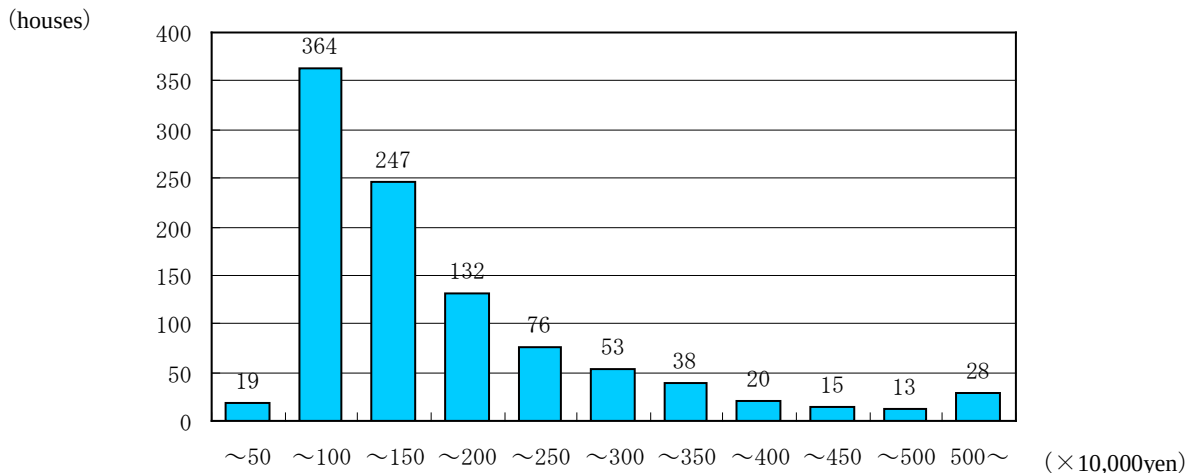


Fig. 6—Number of houses by the cost bracket of reinforcement work in FY2014

Measures for elderly households are one of the challenges to be tackled in the future. Nearly half of the victims of Hyogo-ken Nanbu Earthquake in 1995 were aged 65 or higher. Since it is not easy for the disaster weak such as the elderly and the handicapped to obtain information in case of a disaster, it is difficult for them to evacuate quickly.

According to the 2013 National Housing and Land Survey, the number of elderly households aged 65 years or older living in wooden houses built under the old earthquake resistance standards is estimated to be approximately 181,000, which is 61.8% of the total number of wooden houses (approx. 293,000 houses) built under the old earthquake resistance standards. This rate is expected to increase in the future.

In order to guide the elderly households which are reluctant in seismic retrofitting in the future, it is important that they take precise measures. A system to send experts who will prepare the retrofit plan free of charge was added in Fiscal 2016 to make it easier for them to start seismic retrofitting in addition to the reinforced consultation system for households comprising only of the elderly and so forth.

Since there are still many wooden houses with low earthquake resistance and high risk of collapse which were built under the old earthquake resistance standards while the urgency of Tokai Earthquake is claimed, it is necessary that the earthquake-proofing of houses through Project “TOKAI-ZERO” is further promoted and that the goal for earthquake-proofing of houses be addressed as quickly as possible. Earthquake-proofing of houses cannot be implemented easily. It is considered important that various promotion measures are taken steadily and one by one.

7. Acknowledgements

In every stage from launch through promotion, this project couldn't have been realized without the support and cooperation of the national government, scholars and professionals in the field, architects and building engineers, and many other people. The subsidy system for seismic retrofitting of houses is now spreading throughout the country. We would like to see the support measures expand, new technologies develop in private sectors, and many old houses undergo seismic retrofitting; through these efforts, it is our sincere hope to reduce, as much as possible, the number of victims in large-scale earthquakes that are anticipated in the future.