

# QUICK INSPECTIONS OF DAMAGED BUILDINGS DUE TO 1995 HYOGO-KEN-NAMBU EARTHQUAKE

by

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## INTRODUCTION

Mitigation of secondary disaster due to aftershocks is one of the most essential issues after a major earthquake. Following the Hyogo-ken-Nambu Earthquake (Kobe Earthquake) on January 17, 1995, quick inspections of damaged buildings were systematically carried out for the first time in Japan to assess their potential risk due to aftershocks, and the importance of such activities was highly recognized. In this paper, the inspection operations are briefly described and problems that should be solved for future earthquake preparedness measures are discussed.

## BACKGROUND HISTORY OF QUICK INSPECTIONS IN JAPAN

*Table 1* summarizes the background history of quick inspections in Japan. The importance of post-earthquake inspection and evaluation of damaged buildings has been strongly recognized in Japan since 1980 Southern Italy Earthquake. One of the most essential lessons learned from the quake was the needs of post-earthquake inspection of damaged buildings since people in the affected areas were afraid that their houses might collapse due to aftershocks and they needed reliable inspections to identify safety/risk of damaged houses.

Reflecting these circumstances described above, a five-year National Research Program on Development of Rehabilitation Techniques for Earthquake Damaged Structures started in 1981, and a guideline for post-earthquake inspection and evaluation of earthquake damage to structures was drafted in 1985. The guideline<sup>[1]</sup> consisted of two basic procedures, (1) quick inspection of potential risk due to aftershocks and (2) damage classification and decision of necessary treatment such as repair, strengthening or demolition. The guideline was also applied to approximately 20 buildings damaged by 1985 Mexico Earthquake and its effectiveness was confirmed.

To disseminate the knowledge and techniques of post-earthquake inspection, "Standard for Evaluation of Damage Level of Earthquake Damaged Buildings and Guideline for Repair Techniques<sup>[2]</sup>" was developed based on the guideline and published by the Japan Building Disaster Prevention Association in 1991. At the same time, the post-earthquake inspection plan has been prepared in some local governments in Japan. The Shizuoka Prefecture where a large scale earthquake ( the "*hypothetical Tokai Earthquake*") is predicted to occur in the near future, was the first local government to develop post-earthquake preparedness program. Kanagawa and Tokyo Prefectures also followed the establishment of the program.

The Standard was applied to several hundred buildings affected by 1993 Kushiro-oki and 1994 Sanriku-haruka-oki Earthquakes. It was, however, the first time to apply the Standard to a huge number of damaged buildings and problems involved in the current inspection system were revealed.

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## **BASIC CONCEPT OF QUICK INSPECTIONS**

The Standard consists of two procedures, i.e., (1) quick inspection and (2) damage level classification, and check-list sheets corresponding to each structural type (reinforced concrete, steel, and wooden structures) were provided to facilitate the judgement for both procedures. Quick inspection aims to identify short-term safety due to aftershocks following a major quake, i.e., safety of a damaged building for dwelling and/or access to the building and RED/YELLOW/GREEN labels are posted depending on the risk while damage classification aims to identify long-term safety, i.e., necessary treatment such as repair, strengthening or demolition. After the Hyogo-ken-Nambu Earthquake, the quick inspection procedure was mainly applied to buildings in the affected areas. The quick inspection requires exterior and interior surveys on (1) damage to foundation and superstructures and (2) objects likely to fall down or to turn over during aftershocks. Each item includes more detailed sub-items such as degree of differential settlement, ratio of heavily damaged columns/walls etc. Detailed description of the quick inspection procedure can be found in Ref. [3].

## **QUICK INSPECTIONS FOLLOWING THE EARTHQUAKE**

*Table 2* summarizes the sequence of quick inspections and the number of inspected buildings after the earthquake. Immediately after the quake, staff of Kobe city local government posted RED tags which showed "DO NOT USE" on obviously hazardous buildings as a first stage post-earthquake activity. However, the number of damaged buildings was too numerous to post RED tags on all hazardous buildings and copied black-and-white tags were used for most buildings and therefore the first activity was referred to as "BLACK TAG POSTING" as shown in *photo 1*. The Ministry of Construction initiated the systematic quick inspection activities, and supported the first stage activities carried out by the Kobe city and posted black tags mainly on office buildings. In the second stage activities, the Ministry of Construction also continued to inspect reinforced concrete apartment buildings with more than 3 stories, and RED/YELLOW/GREEN labels were posted based on the definition in the Standard as shown in *photo 2*.

In parallel with these two activities described above, an inspection system by voluntary engineers and architects who belonged to related associations and institutes of building structures was also organized since the number of damaged building was definitely too many to be covered by these two activities. The voluntary inspectors walked around the affected areas mainly to inspect individual wooden houses and gave advice without posting labels.

## **WHAT DID WE LEARN FROM THE DESTRUCTIVE EARTHQUAKE?**

Lessons learned from the 1995 Hyogo-ken-Nambu Earthquake revealed the importance of the following system and activities for the rational and effective inspections in the future.

(1) Quick but kind and polite care is most needed.

People in the affected area may be emotionally unstable and therefore quick but humane care is most needed.

(2) Change of people's feeling should be recognized.

Immediately after the quake, people were most concerned about the safety to stay in their houses. As time passing, however, they paid much more attention to compensation for damage and to receiving an official certificate describing their damage. Since quick inspections should be performed immediately after the event as its name implies, preparedness for prompt inspection after a major quake is most important.

(3) The idea of quick inspection should be more clearly explained to building owners.

After the quake, each local government issued a certificate describing "partially damaged", "halfly collapsed" or "totally collapsed" to identify building damage. This certificate was related to tax reduction or compensation for damage, and therefore the damage should be

identified based on the economic loss for each building owner rather than potential risk due to aftershocks, and the certificate should be considered *independent* from quick inspection results. However, building owners often believed that *Red Tag/Label* (unsafe) directly corresponded to "totally collapsed" even if the *Red Tag/Label* was attributed to potential risk due to damaged window panes. Misunderstanding of basic concept for quick inspection among inspectors, building owners and even municipal officials caused confusion and trouble after the quake. It is therefore strongly desired to disseminate the basic idea for quick inspection activities.

(4) Development of quick inspectors system throughout the country is most important.

A large scale disaster definitely causes difficulties in post-earthquake inspection activities by those in the affected area. Development of inspectors system to cooperate and support the affected areas from outside is necessary. To this end, training of inspectors throughout the country is most needed to develop and activate the regional cooperative system

(5) Development of database on building stock is needed.

To roughly estimate the damaged area and the number of inspectors needed and to precisely identify the damage distribution, database containing fundamental information on existing building stock such as structural type (RC, steel, wooden structures etc.), use, the number of stories, construction year etc. needs to be developed in each local government. Utilization of GIS may facilitate to develop such database as well as to perform quick inspection. At the same time, data obtained by different organizations need to be exchanged and shared to eliminate duplicated efforts.

(6) Preparation of simplified inspection procedure is desired.

Check-list sheets prepared in the current Standard<sup>[2]</sup> were used in the quick inspections after the event. They required, however, too detailed surveys as compared to the tremendous disaster in and near Kobe area. In addition to the existing procedure, a simplified procedure is strongly desired reflecting what is learned from the disaster. For prompt and effective post-earthquake activities following an earthquake, it is also essential to train decision makers and coordinator so that they might take the most appropriate operation.

## CONCLUDING REMARKS

The Hyogo-ken-Nambu Earthquake has served us with a wake-up call and demonstrated the urgent need for post-earthquake preparedness measures. Recognizing importance of post-earthquake activities, a special committee was organized to discuss a broad array of issues related to quick inspection activities and to revise the current system. They include:

- incorporation of inspection system in law,
- development of a simplified inspection procedure and typical label format to describe and inform inspection results,
- prioritization of building types to be inspected, and
- establishment of mutual cooperation system with other jurisdiction etc.

Of course, the author wishes that no disaster may occur and such inspection system may not be utilized. However, only the God knows when and where the next quake may attack and we should be well prepared for the next one to mitigate earthquake disaster. We can not afford to wait for the next earthquake disaster.

## REFERENCES

- [1] The Ministry of Construction "Manual for Rehabilitation Techniques for Earthquake Damaged Structures," Report on the National Research Program on the Development of Rehabilitation Techniques for Earthquake Damaged Structures, 1986 March.
- [2] The Japan Building Disaster Prevention Association "Standard for Evaluation of Damage Level of Earthquake Damaged Buildings and Guidelines for Repair Technique," February

1991.

- [3] Masaya Murakami "Post-earthquake Inspection and Evaluation of Earthquake Damage in Buildings for Countermeasure," Proceedings of the 8th International Research and Training Seminar on Regional Development Planning for Disaster Prevention Emergency Assessment System of Damaged Buildings, 16 January 1995, Osaka, Japan, United Nations Center for Regional Development
- [4] Yoshiaki Nakano "Quick Inspections of Damaged Buildings Due to 1995 Jan. 17 Hyogoken-Nambu Earthquake," Journal of Japan Society for Natural Disaster Science, Special Issue, 1995 July. (in Japanese)

*Table 1: Background History of Quick Inspections in Japan*

Year	Earthquakes	Event
1980	Southern Italy	
1981		National Research Program on <i>Development of Rehabilitation Techniques for Damaged Buildings</i>
1985	Mexico	Development of Guideline Application of Guideline to approximately 20 Buildings in Mexico city
1991		Publication of Revised Guideline
1992		Establishment of Inspectors System in Shizuoka and Kanagawa Prefectures
1993	Kushiro-oki	Application of Standard
1994	Sanriku-oki	Application of Standard
<b>1995</b>	<b>Hyogo-ken-Nambu</b>	<b>Application of Standard</b>

*Table 2: Time Sequence of Inspection Activities by Different Organizations and Number of Inspected Buildings*

Kobe city (Staff of Kobe city)	Ministry of Construction with Staff of Local Government	Volunteers (Engineers and Architects)
<1st stage> posting <i>BLACK TAGS</i> to obviously hazardous buildings	<1st stage> support of <i>BLACK TAGS</i> posting to mainly office buildings	preparation for setting-up a supporting committee for damage inspection
	<2nd stage> posting RED / YELLOW / GREEN Labels mainly to R/C apartment houses with more than 3 stories	round-inspections of individual wooden houses <i>without Posting Labels</i>
approx. 2,800 hazardous buildings	46,610 R/C apartment houses by 5,068 man*day RED: 6,476 YELLOW: 9,302 GREEN: 30,832	35,658 individual wooden houses by 5,564 man*day



photo 1: Tags showing "DO NOT USE" (left: original / right: copied)

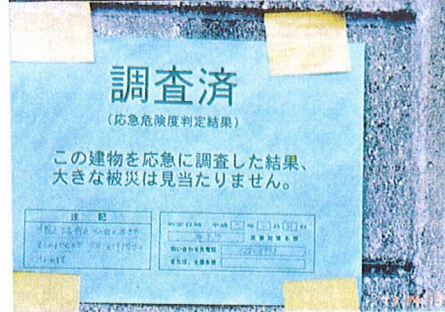
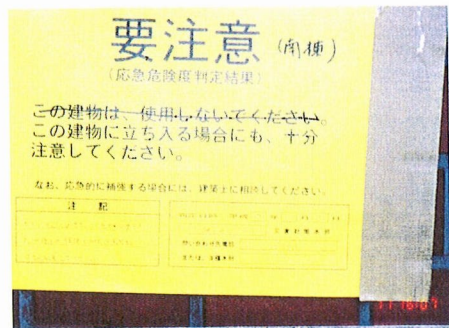
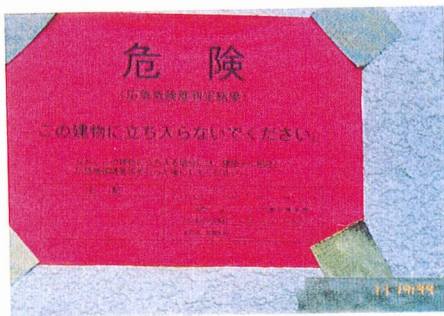


photo 2: Labels for Quick Inspection Results showing "UNSAFE", "LIMITED ENTRY" and "INSPECTED" (in clockwise)