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Session Report
SURVEY METHODS AND QUANTITATIVE EVALUATION OF EARTHQUAKE DAMAGE

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SUMMARY

A special theme session titled "Survey Methods and Quantitative Evaluation of Earthquake Damage" was held to improve methods for accumulating experiences in destructive earthquakes. Ten papers forcusing on the following three sub-themes were presented: (1) earthquake intensity; (2) effects on natural environment and property damage; and (3) human behavior and casualty. A period for questions-and-answers was provided having been followed by a state-of-the-art report and an On-site closure.

INTRODUCTION

Many useful experiences in damaging earthquakes have not necessarily been accumulated in engineering societies and communities in an effective way to be used to mitigate future earthquake disasters but tended to be forgotten once after the difficulties due to the eatquakes were over. There are naturally categories of damage on which many experiences have been accumulated and introduced into disciplines for earthquake-hazard mitigation; e.g. those concerning structural engineering, geotechnical engineering, etc., i.e. mainly disciplines concerning man-made structures. On the other hand, there are categories of effects on which not much information has been accumulated; e.g. widely-spread effects on natural terrain, effects on human behavior, short- and long-lasting inconveniences to residents' lives. It is regrettable that such painful and irreplaceable experiences are forgotten in vain.

This situation has likely been caused not only by that the description of hazards of the latter categories was difficult but also by that relatively few researchers have been concerned with those types of hazards. It is therefore important to establish procedures for describing such unfamiliar types of damage to facilitate accumulation of data, and also to call attention of researchers to this feature of effects.

From the above point of view, we have organized this session to encourage studies that are broader in scope and more extensive in time than has been usual in past damaging earthquakes. As the first trial we have adopted the following three aspects as the sub-themes in this session: 1) earthquake intensity; 2) effects on natural environment and property damage; and 3) human behavior and casualty. Although we have chosen only three these damage categories, there are many other unfamiliar but important categories. We hope therefore this session will be a starting

point of our efforts to describe earthquake disasters more comprehensively and to accumulate our experiences more effectively in future earthquakes.

PRESENTATIONS AND DISCUSSIONS

Ten papers were presented under three sub-themes; two under EARTHQUAKE INTENSITY (Kagami et al., Astroza and Monge); four under EFFECTS ON NATURAL ENVIRONMENT AND PROPERTY DAMAGE (Kanoh et al., Tiedemann, Elnashai et al., Umemura et al.); and four under HUMAN BEHAVIOR AND CASUALTY (Durkin and Ohashi, Mochizuki et al., Kosaka and Shiono, Shiono). It was regrettable that four other anticipated authors could not attend the conference and as a consequence a part of the session has become somewhat less comprehensive. It was partly supplemented by the state-of-the-art report given after the discussion period. Main questions and answers as well as discussions made in the session were as follows:

Questions and a comment to Astroza and Monge

Question: Was there any reason the authors did not apply a standard attenuation equation and relate the residual of intensity with geology types?

Answer: As the only attenuation curve, which is for gravel sites, was proposed in Chile, we tried in this study to derive attenuation curves for other geology types.

Comment: It would be more reasonable to use an attenuation curve for rock sites as a standard curve and evaluate the residual of seismic intensity with geology types as the effect of soil amplification.

Question: What was the source of the damage data?

Answer: Field inspection six months after the event.

A question to Kanoh et al.

Question: Have you made any recommendation to use elastic connection of the sewage pipes to the manhole?

Answer: No, because it affects the construction cost greatly.

A comment to Elnashai et al.

Comment: The difference between measured elastic response spectra and design spectra cannot always be explained by numerical factors related to non-linear behavior. We may have to use an additional reduction factor related with more detailed characteristics of ground shaking.

Question to Tiedemann

Question: What was the survey power, sample size, and analytical methods necessary to achieve the results?

Answer: A team of engineers investigated 1,200 damaged buildings using a detailed inspection form.

Question: What criteria have been applied in drawing the border line between "soft" and "stiff" buildings?

Answer: Detailed study to establish the criteria was done, but was not mentioned in this presentation.

A question and a comment to Umemura et al.

Question: Has any effort been made to develop engineering inspection methods for the rescue operation to insure safety of rescures and to optimize rescue effort?

Answer: No, that is the responsibility of rescures.

Comment: This answer suggests a futher need.

Questions and comments to Durkin and Ohashi

Question: Do the authors have data on specific cause of deaths in

either of the buildings pursued? What specific injuries did people die of?

Answer: The authors still do not have complete data.

Comment: This should be studied.

Question: Did the study take into account the cause of occupant movement patterns within buildings during the earthquake event?

Answer: No. The authors investigated only what was done and where in a specific floor plan it was done.

Question and comment: To where this kind of research will lead us? I understand that, as a structural engineer, when buildings collapse, people either get injured or dead depending on many situations, the effort is to find out the causes of the damage to the buildings due to earthquake and to take appropriate measures in design and construction of buildings so that these types of buildings do not collapse and people do not get killed. In questioning people, they will provide varied answers and it may be difficult to find a unique pattern of behavior, and any suggestions or recommendations may be quite a misleading advice.

Answer: Our efforts are to document not only occupants' behavior but also (1) the general level of the impact of building damage to occupants, or casualty rate, in various patterns of building collapse. The result will be useful in the estimation of potential casualties in future earthquakes with due consideration of collapse pattern. And (2) the occupants' physical setting which contributed to their life safety: for example, the effects of building contents which prevented total collapse of a building. The result will be useful when we evaluate the contribution of actual physical setting in a building, either positive or negative, in promoting safety. It is also important to investigate generally what an occupant could do for his safety in a specific collapse pattern of a building, because we can provide general suggestions or recommendations to the occupants in a specific type of construction.

A question to Mochizuki et al.

What is the authors'advice based on their research findings for education programs for disaster safety?

Answer: At the present stage, we do not have any specific plan.

A question to Mochizuki et al. and to Shiono and Kosaka

Question: How is the survey result from the 1948 earthquake applied to present day disater prevention? Namely, how can we adjust the change of wooden dwelling characteristics? Mass casualty, not fatality, due to non-structural elements is the major problem at present.

Answer: As the casualties in the 1948 earthquake were related to the sudden collapse of non-ductile (wooden) dwellings, the survey result can be applied generally to accidients in non-ductile structures such as adobe or unreinforced masonry buildings.

CONCLUDING REMARKS

After a state-of-the-art report titled "Towards extended field surveys and assessments in an earthquake" by Professor Yutaka Ohta , a closing statement was given by Professor Michael E. Durkin.

Durkin summarized the general trend of research activity during the last four or five years as follows:

1. Progress in each research suject including broadening of issues in concern and tightening up of methodology;
2. Attempts to make connections between study areas, for example, attempts to study impact of non-structural damage from the perspective of casualties and to study the impact of facility damage from the perspective of function disruption;

3. Expansion of the time frame in concern from the period during and immediately after the earthquake to the period for short- and long-term recovery process.

He pointed out further that the future task for us is to try to put all aspects together making even efforts in each study issue, and that we should direct our efforts not only to look for connections in our own area's specialization but also to start transcending those areas and to begin to develop a comprehensive framework of earthquake assessment.

As is evident from the previous section, some of the discussions were directed to technical implications of phenomena probably because many participants had not been used to the aspect of this session. Most of the discussions, however, were concentrated on survey methods and quality of acquired data, and even on the applications of the study results. The questions, whether the results were used for recommendations or education programs, are in this respect important, since they suggest a potential use in the future of the kind of study results dealt with in this session, however the application of them has been so far unsatisfactory.

In conclusion, this session was successful as the first step of this kind of trials, since more number of participants (about 100) than anticipated were present throughout the session, and active discussions were roused. It has certainly stimulated the interest of researchers in the issues which we believe are important for future development of earthquake-hazard mitigation.

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