THE BEHAVIOR OF PEOPLE IN DWELLINGS DURING THE OFF-URAKAWA EARTHQUAKE OF MARCH 21, 1982

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SUMMARY

This study utilized an in-depth interview procedure to reconstruct the courses of action taken by 41 inhabitants of dwellings during the off-Urakawa earthquake of March 21, 1982 and to identify the relationships between those actions and the performance of the building systems, subsystems, and contents which surrounded them during the period of strongest ground motion.

INTRODUCTION

It is often assumed that, during major earthquakes, the ground motion will be too strong or the time will be too short for building occupants to pursue any actions which could affect their own survival or that of others. Until now there has been very little research to justify these assumptions. The few studies which have been published suggest that a great deal of activity may actually occur during earthquakes and that some of these activities may have unanticipated negative consequences for those who pursue them (Refs. 1 and 2). Similarly, recent research on human behavior during building fires has shown that people often respond to such emergencies with a subjective kind of rationality which may appear to have been totally counter-productive when viewed after-the-fact by uninvolved observers (Refs. 3 and 4).

Following the lead taken by researchers in the fire area, this study focused on the courses of action taken by building occupants during a specific earthquake and on the relationships between those actions and the performance of surrounding building elements, furnishings, and other occupants while the earthquake was occurring. The major questions addressed by this study were:

(1) How much activity can people actually pursue during the period of strongest ground motion caused by an earthquake?

(2) Do they attempt to engage in any more than the minimal amount of activity required to protect themselves?

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SETTING

The March 21, 1982 earthquake near Urakawa on the southern coast of Hokkaido, Japan was selected as the setting for this study for the following reasons:

(a) it was the strongest earthquake to strike an inhabited area in an accessible part of the world during 1982

(b) despite extensive building damage, most structures remained sufficiently intact to permit on-site investigations after the event

(c) there were too few serious casualties to create widespread grief reactions among the potential subjects.

Urakawa is a fishing and horse breeding community with a population of 19,408 as of 1980. It is near the center of a very active seismic zone. In 1952 and 1968 earthquakes registering 8.1 and 7.9 on the Richter Scale were centered approximately 150 kilometers east and 250 kilometers southeast of the town, respectively. In January, 1981 Urakawa experienced an earthquake with a magnitude of 6.7 on the Richter Scale. In the 14 months between January, 1981 and March 21, 1982, noticeable tremors were being experienced in Urakawa almost every day. Given the frequency with which they had been experiencing foreshocks and the relatively low casuality rates that were reported, it would appear that the residents of Urakawa were about as well prepared for the earthquake of March 21 as could be expected.

The March 21, 1982 tremor struck at 11:32:20 AM on a Sunday morning. The period of strongest ground motion lasted 30 seconds. This earthquake had a magnitude of 7.1 on the open-ended Richter Scale. Using the scale adopted by the Japan Meteorological Agency, it was determined to have had an intensity between 5.0 and 6.0 at various locations in the center of Urakawa. This corresponds to an intensity between 9.0 and 10.0 on the Modified Mercalli Scale.

There were 141 damaged dwellings in the town of Urakawa. However, most of these continued to be occupied after the earthquake. An additional 545 dwellings were damaged in adjacent communities. Forty-two percent of all the injuries that were recorded for the March 21 earthquake occurred in the town of Urakawa. Only 9 of the 82 injuries that occurred in Urakawa were listed as serious. There were no fatalities.

PROCEDURE

A total of 41 persons who had been in their homes at the time of the March 21 earthquake were interviewed in August, 1982. This was approximately 5 months after the event. All interviews took place in the settings that the subjects had actually occupied during the earthquake. Subjects were selected on the basis of the calculated intensity of the tremor in the general vicinity of their homes, using data on the extent of structural damage that had been compiled by Professor Yutaka Ohta and Ms. Hitomi Ohashi at Hokkaido University in Sapporo (Ref. 5).

The sample included 15 and 16 subjects, respectively, from Tokiwamachi and Higashimachi, which were the two districts in which the intensity of the earthquake was found to have been greatest. There were 7 subjects from Sakaimachi which is situated on an alluvial plain in which the shaking was somewhat less intense. The remaining 3 subjects were from the outlying district of Ogifushi.

In addition to obtaining background data on matters like age and the state of the household at the time of the earthquake, each subject was asked three series of questions pertaining to:

(a) the sequence of their own actions during the 30-second period of strongest ground motion

(b) the sequence in which they observed any structural or non-structural displacement during this period

(c) their observations of the activities of other occupants of the dwelling during the earthquake.

On the assumption that people create accounts of their experiences in disaster situations to justify their contributions to the final outcome, the subjects were initially encouraged to report what they did or saw just as they remembered it. The remaining questions were ordered in such a way that successive responses would refine and correct the data on the sequence in which each of the reported actions actually occurred. Specific questions were asked about the locations at which each activity took place or was attempted and the vantage points from which damage or the behavior of others was observed.

Each subject also walked through the entire sequence of activities which they had pursued during the 30-second period of strongest ground motion. Their paths of travel, the locations at which all reported actions were taken, and the points from which they observed specific events around them were then plotted on measured floor plans which were made for each dwelling.

FINDINGS

Detailed analysis of the field data indicates that the subjects engaged in an average of 5 distinct actions during the 30-second period of strongest gorund motion. Thirteen of the 41 subjects (31.7%) reported that, when the shaking started, they just stayed where they were until they determined its severity. Most of these subjects eventually pursued other activities. Only six subjects (14.6%) remained in the same location throughout the entire period of strong ground motion.

The distances travelled from the time that the subjects first noticed the earthquake to the time that the strongest shaking stopped, averaged 27 feet. Six subjects moved more than 50 feet during this period, with the greatest distance travelled being 174 feet. Although this seems like a great distance, a person travelling at a normal fast walking pace of 7 feet-per-second (Ref. 6) could have gone 210 feet in the same 30-second period.

The specific activities pursued by the subjects were related to reducing the risk of fire, protecting one's property, going outside, and protecting onesself. Each of these activities will be presented in turn.

Reducing the Risk of Fire

Nineteen of the 41 subjects (46.4%) acted to reduce the possibility of fire by turning off their portable oil stoves. These 19 subjects travelled an average of 9'-3" to turn their oil stoves off. In a typical Japanese house, this is equivalent to moving all the way across a room. Interestingly, most of these oil stoves were known to have been equipped with automatic flame supression devices (although it was reported that these were only 90% effective during the 1982 earthquake).

In other action intended to reduce the possibility of fire, seven subjects (17.1%) turned off the gas cock behind the kitchen range. They travelled an average of 5'-10" to do so. Twenty-one of the 26 instances of turning off oil stoves and gas cocks (80.8%) were listed among the first two actions taken by the subjects. This suggests that reducing the risk of fire was a very high priority for the dwelling occupants interviewed in this study.

Protecting Property

Sixteen of the subjects (39.0%) attempted to brace free-standing cabinets or bookshelves with their bodies in order to keep these furnishings and their contents from falling to the floor. They travelled an average of 9'-4" to do this. This suggests that they were not simply trying to keep these things from falling on top of themselves, but were actively moving across a room to protect their property. Note that most of this property was not insured.

None of these 16 subjects were successful in keeping their furniture from falling (although many of them had been successful during the less intense earthquake in 1981). Two of these subjects (12.5%) were struck by a falling object while they tried to brace their cabinets.

In addition, seven subjects (17.1%) reported that they tried to hold onto other objects to keep them from falling or breaking. Since this group travelled an average of only 4'-8" to hold these objects, it would appear that this action was more fortuitous than deliberate.

Although a few subjects attended to their possessions right away, the percentage who braced cabinets or kept objects from falling tended to increase as the earthquake progressed. The average distance travelled to protect property also tended to increase throughout the period of strongest ground motion. This suggests that actions directed toward property became less fortuitous and more goal directed over time.

Going Outside

Ten of the subjects (24.4%) actually ran out of their house or apartment at some point during the earthquake. Six more attempted to go

outside, but were unable to do so. Those who succeeded in getting out travelled an average of 18'-1" from the point at which their previous activity had occurred to their destination outside.

Three of the 10 subjects who went outside (30.0%) changed from their house slippers to their street shoes as they passed the entry hall. Two subjects (20.0%) fell on their entry stairs as they went outside.

Protecting Oneself

Only 3 of the 41 subjects (7.3%) tried to protect themselves from falling objects by getting under a piece of furniture or some other cushioning device. Only two of them were successful.

One woman successfully got under a folding mattress that was normally used for sleeping. Another woman ducked into the bottom of her bedroom closet where she was cushioned by the clothes hanging above her. The subject who was unsuccessful reported that, as she tried to get under her kitchen table, her refrigerator was falling onto the table and another cabinet was falling onto the refrigerator.

These three subjects travelled an average of 15'-9" to seek safe refuge. This means that, in order to protect themselves, they had to travel to another room. Comparing the 10 subjects who chose to travel an average of 18'-1" to go outside with the 3 subjects who travelled an average of 15'-9" to take cover, suggests that the former course of action was perceived to be more advantageous than the latter.

It was also found that there were very few pieces of furniture that a person could have gotten under in the 27 homes studied. When the earthquake began, only 8 of the 41 subjects (19.5%) were in a room which contained a piece of furniture that could have afforded them protection. Eight more of the subjects (a total of 39.0%) passed through a room that provided such refuge as the earthquake continued.

Of the 14 instances in which a subject passed directly next to a piece of furniture that could have provided safe refuge, only one (7.1%) resulted in an attempt to protect oneself. That attempt was the one that was unsuccessful. The remaining 13 subjects travelled an average of 19'-0" after passing a potential place of refuge. Three of these subjects (23.1%) eventually went outside.

CONCLUSIONS

Based on the data from the March 21, 1982 Off-Urakawa earthquake, the following conclusions emerge:

(1) The subjects were able to engage in a number of different kinds of activities and to travel considerable distances during the 30-second period of strong ground motion.

(2) The most prevalent and immediate responses were associated with reducing the subsequent risk of fire. This may be uniquely related to

housing conditions in Japan (especially the use of portable oil stoves to provide heat and humidity during the winter months).

(3) Very few of the subjects attempted to protect themselves from falling objects during earthquake itself. This appears to have been due to the following factors:

(a) there were very few pieces of furniture available within these houses that were large enough to provide refuge

(b) the paths to the refuge zones that were available were often obstructed by falling or shifting objects

(c) the distances that subjects would have to have travelled to reach an available refuge zone were so great that other options, such as going outside, became equally or more attractive.

(4) An unexpectedly high percentage of the subjects attempted to protect their property by bracing their furniture with their bodies or by holding onto small appliances and utensils.

(5) The urge to protect property appeared to be quite strong, since many of the subjects walked directly past an available zone of refuge enroute to taking such action.

(6) None of the subjects who attempted to protect their property succeeded and two were struck by the cabinets or by their contents as they fell. This suggests that, despite the apparent urgency, such action unnecessarily increased the risk of casualty.

Although these findings are based on a small number of respondents who had experienced a single earthquake, they do suggest that the behavior of building occupants may be a much more critical factor in survival or casualty during earthquakes than has generally been acknowledged. Specifically, they suggest that people may be able to engage in much more activity during the period of strong shaking than has been thought to be possible or appropriate. Clearly further research on the nature of human behavior during earthquakes will be essential for the development of effective public information programs or refuge zone strategies for building occupants.

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