PSYCHOLOGY AND HUMAN BEHAVIOR AT THE TIME OF LARGE DESTRUCTIVE EARTHQUAKES

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SUMMARY

In the occasion of two large earthquakes took place recently in Japan, studies on the human behavior and psychology in the midst of violent earthquake motions were carried out by means of the questionnaire survey method. It was made clear that in the large earthquake vibrations, once the seismic intensity exceeds I=6.0 by JMA scale (I=9.4 by MM) human behavior and psychology became unstable. With regard to the people in very tall buildings they became unstable rather easily in case of large earthquake motions. Behavior and psychology of the mortorcar drivers were investigated when they encountered violent earthquake motions.

1. INTRODUCTION

Along with the progress in the field of earthquake engineering, the technique for the earthquake resistant design and construction of buildings and civil engineering structures have developed significantly. Strengthening of buildings and other structures against earthquakes is the basic guide line for earthquake hazard minimization.

Recently, however, it has become noticed by many people that the problem of human behavior and psychology in the midst of violent earthquake motions has no less importance than the scientific and technological anti-seismic measures, seen from the side of earthquake hazard minimizations.[1)]

At the time of violent earthquake motions, wide spread confusion will take place unavoidably, in the midst of roaring noises and severe vibrations which might be followed by the crushing down of buildings and houses, breaking out of fires from here and there. People well at a loss how to escape from such a dangerous site to the place where more large safety is secured. Excited by the surrounding circumstances, the mental instability will easily be spread over in the people, creating a well prepared breeding ground for bringing about a panic.

In such a panic circumstances, it is quite clear that the refuge plannings which might had been prepared only from the view point of scientific and technological measures, even if such measures might had been constructed with careful considerations, it will be very difficult to expect that they can make good functioning in accordance with the expected schedule.

In order to avoid falling into such a panic status it becomes greatly important to make pre-estimation on the behavior which a person may take when one encounters the very large and very violent destructive earthquake. This is a problem of human psychology. The problem of human psychology in the midst of a large destructive earthquake, however, has been studied very

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little in the past, and so, there are almost no data so far to be refered to. In this paper two results of the questionnaire surveys[2] on the problem of human behavior and psychology in the midst of violent earthquake motions are introduced. One is the survey carried out in the Oita area, the other is the survey carried out at the Sendai area soon after the two large Japanese earthquakes of 1975 and 1978 respectively.

2. UNSTABLE MENTAL STATUS WHEN SEISMIC INTENSITY EXCEEDS 6 BY JMA SCALE

The questionnaire we used contained 34 questions. For each question, there were prepared 5 answers asking the person who received the questionnaire to give one check among these 5 answers in accordance with his or her experience at the time of earthquake motions. Among these 34 questions, 29 were related to the problem of ground vibration, therefore by the aid of the electronic computer, it was so arranged as to give one sheet of questionnaire could give one seismic intensity expressed in a decimal of unit intensity of JMA scale.

Another 5 questions among 34, were related to human behavior and psychology. These questions and prepared answers were as follows:

[20] How much were you surprised when you noticed the earthquake?
[answer] 1. I was not surprised at all. 2. I was surprised a little bit. 3. I was pretty surprised. 4. I was surprised very much. 5. I was extremely surprised.

[21] How much were you frightened then?
[answer] 1. I did not feel frightened at all. 2. I felt frightened a little bit. 3. I felt pretty frightened. 4. I felt very frightened. 5. I felt it as a hopeless situation.

[22] Then, how did you behave?
[answer] 1. I considered no action was necessary to take. 2. I attempted to take necessary action for my own safety. 3. I ran away. 4. I dashed out into the street unconsciously. 5. I did not remember my action well because I behaved instinctively.

[23] What did you do about fire? (gas heater, kerosene stove or something like that)
[answer] 1. I was not using fire at that time. 2. I was using a fire but did not consider it was necessary to put it out. 3. As felt danger, I put it out. 4. I put it out unconsciously. 5. I wanted to put the fire out but I could not.

[27] Those who were driving a car, did you have any difficulty in driving the car?

This kind of questionnaire survey were carried out at the time of two earthquakes, the Oita earthquake[3] (M=6.4) and the Miyagi-oki earthquake (M=7.4). With both cases we obtained exactly alike results. Therefore first of all the result of the analysis on the answer to a question No.20 at the time of the Oita earthquake will be explained ("Fig. 1"). Seismic intensity worked out from each questionnaire was classified in accordance with the degree of intensity of which class interval was given by a decimal of unit intensity of JMA scale. In the hope of giving good understanding to the foreign readers, in the figure, the Modified Mercalli Intensity Scale is also indicated side by side with the JMA scale. Within each class the percentage of the respective 5 answers was worked out and shown on the

ordinate in "Fig. 1".

As will be seen in the figure, answers are represented by four curves showing clear characteristic peaks at the intensities 3.0 and 5.1 respectively for the different extent of surprise which was expressed by the words "little and pretty" and "very". It may be quite natural that for the intensity 1 or 2, nearly 100% people answered that they were not surprised at all, but the most noticeable point in the figure lies in that the people who answered, "I was extremely surprised", began to increase abruptly when the intensity reached 6 and then at the intensity of 6.2, 100% of the people expressed the supreme surprise.

Nearly the same figure is obtained in "Fig. 2" for Question No.21 which asked for the degree of fright. As was the case of extent of surprise, the most noticeable point in "Fig. 2" is that the people who answered that they felt a hopeless fright, began to increase rapidly when the intensity became larger than 6.0, then over 6.3 almost 100% of people give the answer "hopeless".

Likewise nature is also seen in "Fig. 3" which shows the result of Question No.22 with regard to the actions taken in the midst of earthquake shock. In the figure the answers No.2 and No.3 were put together and expressed as "conscious behavior", No.4 and No.5 were put together as "unconscious and instinctive behavior". As will be seen in the figure at the locations where intensity is 1 or so, 100% of the people naturally considered it is not necessary to take any action but in proportion to the increase in intensity, most of the people took necessary action so that they could protect themselves from the earthquake destruction, showing the peak at the intensity of 4.5. It is a surprise for us to learn that a few who answered, "I don't remember anything because I behaved unconsciously" are found, even at an intensity as small as 3.7. The number of such people increased quite abruptly when the intensity became larger than 6, and at the intensities over 6.3 almost 100% of the people behaved instinctively.

This result clearly indicates that when a violent earthquake should attack a mass of people, for example, in a big hall, it is quite liable that a panic status will come. From the view point of earthquake disaster prevention, the above point is greatly important to be taken into consideration in establishing a precursory planning in case of emergency. According to the result of our investigation shown in "Fig. 3", it must be pointed out that even in the case where the intensity 5 is experienced, not a few people, namely, about 10% behave instinctively so that they may trigger a panic situation even in such a rather small intensity as 5, in an unlucky circumstance.[3)]

All these three cases mentioned above showed unanimously that at the intensity somewhat larger than 6.0, say about 6.3, which may correspond to the intensity grade of I=9.4 or so by the Modified Mercalli Scale, there is a sort of critical boundary between normal status and unstable status in human mental psychology, when people encountered very severe destructive earthquake motions.

In an epicentral area of the destructive large earthquakes it should

be considered that the seismic intensity must be exceeding 6.0 or may be larger than 6.2 or 6.3. Therefore people are put into an unbalanced mental status. Panic will easily take place. It is clear that such an unusual status is brought about, therefore, in order to establish a plan for disaster prevention measures in the case of a large destructive earthquake, careful and attentive considerations on the human psychology will be called for impractically.

3. HUMAN BEHAVIOR AND PSYCHOLOGY EXPERIENCED BY THE PEOPLE WHO WERE IN THE TALL BUILDINGS OR HIGH-RISE BUILDINGS

At the time of the Miyagi-oki earthquake, with regard to some of the tall buildings in Sendai City, it was reported that larger earthquake damage was observed in the upper floors than the basement floor. Upon these observations, the authors carried out the questionnaire survey for the people who were in the tall buildings and/or apartment houses in Sendai City, as well as some of the tall apartment buildings in Kawasaki City and high-rise buildings in Tokyo. The questionnaire used for this survey was almost same one mentioned above but slightly modified to be used for tall buildings.

Result of the analysis for the answers collected from these very tall buildings showed a definitly noteworthy difference with the result collected from the people who were on the ground or in the dwelling houses of the ordinary height. In "Figs. 4", "5" and "6", these results are reproduced. "Fig. 4" is representing the extent of surprise, "Fig. 5" the extent of fright and "Fig. 6" shows the result of Question No.22 with regard to the actions taken in the midst of earthquake shock. All the a-figures of these tree represent the results of analysis from the people who experienced the earthquake on the ground level while the b-figures are those from the people in the high-rise buildings in Tokyo. Comparing "Fig. 4-a" and "Fig. 4-b", that shows the extent of surprise, peak intensities for the answers "little bit" and "pretty" are giving almost no difference for both cases, while the curve that represent the "extreme surprise" from the ordinary people shows the abrupt increase at the intensity 6.2 just in the same way as was the case of the Oita earthquake. But the same curve obtained from the people in the high-rise buildings in Tokyo shows the abrupt increase at the intensity as low as 5.5 or so.

With regard to "Figs. 5-a" and "b", which represent the extent of fright, nearly same explanation will do. In this case too, the abrupt increase in the curves that show the "hopeless fright" is seen at the intensity 6.3 for the curve analyzed from the answers of the ordinary people while the intensity 5.5 is given in the case of Tokyo high-rise buildings.

"Fig. 6" shows the result of Question No.22 with regard to the actions taken in the midst of earthquake shock. In drawing the figure the actions were expressed in three phrases which read "not necessary to take any action", "conscious" and "unconscious".. The peak intensities of the curve which represent the answer that acted consciously are nearly same for the both cases, while with regard to the action of unconscious, the answers from the ordinary people show abrupt increase at the intensity 6.2 as along quite the same line with the case of the Oita earthquake. But the curve of unconscious action from the people of Tokyo high-rise buildings showed the

abrupt increase at the intensity as low as I=5.5.

Summarizing these three examples it should be taken note that people in the high-rise buildings in Tokyo might be quite calm to the earthquake vibrations in the range of low intensities, but once the earthquake motions exceeded the intensity 5.5 by JMA scale (8.5 by MM) the dormant nervousness to earthquake shocks of the people in the high-rise buildings in Tokyo could be actualized instantaneously. Such an event as mentioned above might trigger the panic status in the high-rise buildings when they are subjected to large destructive earthquakes.

In the course of our discussions herewith extended, however, it must be mentioned that there are many points to be considered before we are deriving the definite conclusions. First, detailed studies are needed for rating intensities from the questionnaires collected from upper floors of high-rise buildings. Second, careful re-examinations should be made why such large intensities as over 6 were obtained from the computer analysis of our questionnaire survey.

4. BEHAVIOR AND PSYCHOLOGY OF MOTORCAR DRIVERS WHEN THEY ENCOUNTERED VIOLENT EARTHQUAKE MOTIONS

Regarding the problem of human behavior and psychology in the midst of the severe earthquake motions, it will provide one of the important information to study in what way a motorcar driver will respond to the violent earthquake when he experienced severe ground vibrations.

For this purpose specially prepared questionnaires were distributed to 600 bus stations and taxi company offices asking the drivers who were driving the car at the time of the earthquake to give their answers. 4,000 sheets of answers returned to the authors showing the collection rate of about 50%. One of the largest distress in analyzing the result was encountered in the difficulty in rating the seismic intensity for the collected each questionnaire. Substantially it is unreasonable to expect that the seismic intensity could be determined from the report of a driver who was just driving a car, even if any kind of questions would be prepared.

In our case, however, intensity distribution throughout the whole shaken area was made clear by means of the questionnaire surveys mentioned in the paper of Narahashi,[2] so it was asked to the drivers to describe the location where they experienced the earthquake as accurately as possible. The entry of each driver on this point was so excellent that the difficulty in rating the seismic intensity for each questionnaire from individual driver was successfully overcome.

Some of the interesting results were obtained. In "Fig. 7" it is shown the extent of fright which the drivers experienced when they encountered the earthquake. Because of the reason that the way of rating the seismic intensity for each questionnaire is different from the way explained in Section 2 of this paper, in this case of "Fig. 7" such large intensities as 6.0 or over were not came out. As we have seen in preceding Section, the critical intensity on which the human psychology became unstable was around I=6.0 or so, that in our present study, unfortunately, this point was not made clear.

Nearly the same result is seen in "Fig. 8", in which the extent of hindrance for driving is reproduced. In this figure it is observed that when the seismic intensity exceeded 4.0, the drivers became to feel some difficulty in driving. Over 5.0 about half of drivers felt that driving was impossible. It is surprising to learn, however, thought it is only a few, some of the drivers answered that they felt no difficulty in driving even at the locations where intensity 5.0 or even 5.5 were rated. On the contrary, a few of them answered that they felt further driving was impossible at the location where the intensity only 3.5 was rated.

As to the question that "what did you do for your driving as soon as you felt the earthquake?", result is reproduced in "Fig. 9". As will be observed from "Fig. 7", almost all drivers halted the driving of the car at the intensity larger than 5.5. But it must be noted that not a small number of drivers answered that though they felt earthquake shock (even intensity 5.0) they continued running.

Another noteworthy event is seen in "Fig. 10". In the figure it is shown the actions taken by the drivers after they halted the car for some time. In Japan it is believed that it is a common drive manner to stop the driving when one encountered such a large earthquake as to feel difficult for driving. In doing so, the emergency traffic such as medical rescue and fire engine, etc. could be ensured.

5. CONCLUDING REMARKS

Questionnaire survey in the case of large destructive earthquakes are calling upon many important items to be taken up for further urgent studies and investigations by which the practical means for minimizing earthquake hazard could be improved most effectively and successfully. Questionnaire survey also raised a serious problem on the mortorcar driving in case of emergency.

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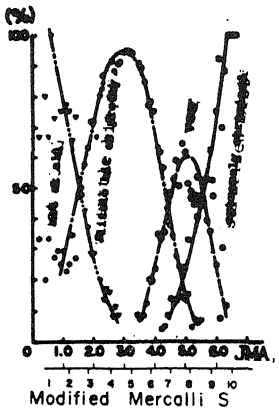

Fig. 1

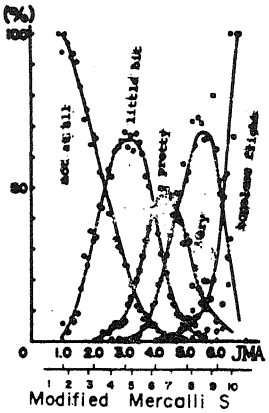

Fig. 2

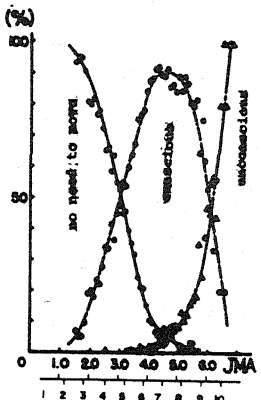

Fig. 3

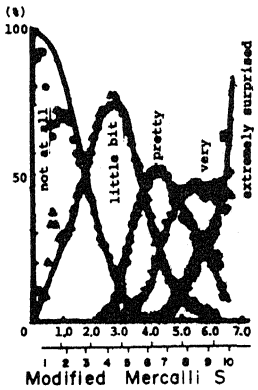

Fig. 4-a

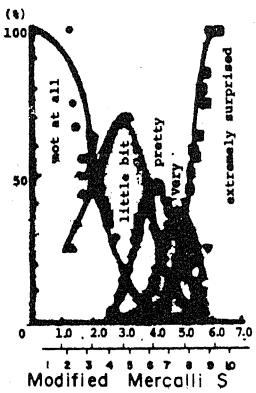

Fig. 4-b

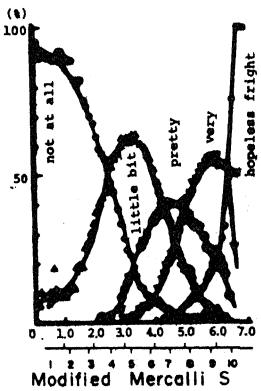

Fig. 5-a

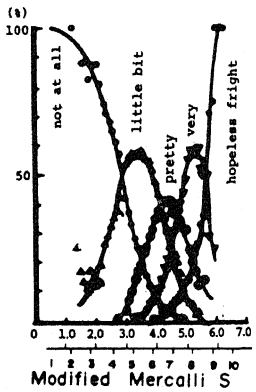

Fig. 5-b

Figures from 1 to 3 are from the Oita earthquake.

Fig. 1
Extent of surprise.

Fig. 2
Extent of fright.

Fig. 3
How did you behave yourself?

Figures from 4 to 6 are from the Miyagi-oki earthquake, a-figures are for the case of people on the ground, b-figures are people in high-rise buildings.

Fig. 4
Extent of surprise.

Fig. 5
Extent of fright.

Fig. 6
How did you behave yourself?

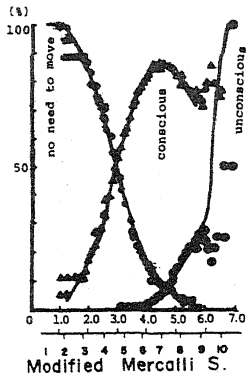

Fig. 6-a

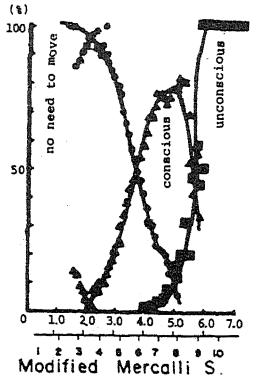

Fig. 6-b

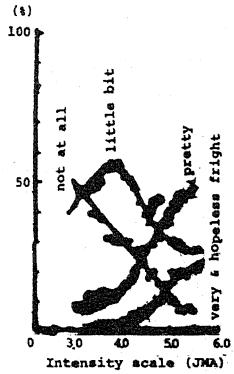

Fig. 7 Extent of fright experienced by motorcar drivers.

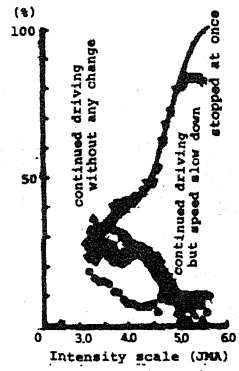

Fig. 8 Actions taken by drivers when they noticed the earthquake.

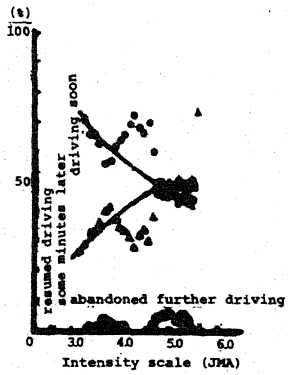

Fig. 9 Whether resumed driving.

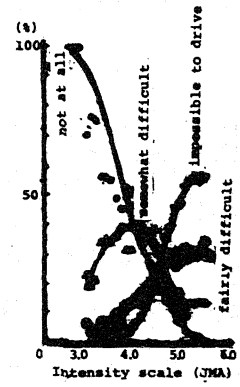

Fig. 10 Extent of difficulty in driving a motorcar.