

Seismic risk communication with owners in structural design

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ABSTRACT: Structural performance decision-making for a building aims to determine the appropriate risk of losing human life and property. Structural engineers need to begin to communicate with owners on matters of risk. This paper describes citizen's attitudes using two questionnaire results as a basic survey to establish a framework of risk-communication methods with building owners. These surveys specify contents and requirements for risk communication for seismic safety, focusing on the owner's trust of engineers and decision-making for performance. The goal of communication is to make a reasonable decision-making of seismic safety performance level for an owner. The respondents are interested in risk communication and information disclosure, and they need an explanation from the engineer. The explanation of performance before the agreement is especially needed. Deriving from two attitude surveys, we considered there was difference of need for dialogue influenced by owner type.

1 INTRODUCTION

Structural performance decision-making for a building is to determine the appropriate risk of losing human life and property. However, private building owners have poor experience and knowledge about risk or decision-making for structural performance. As a result, structural engineers, with support of design codes, decide all performance and risk without consulting or explaining to owners. As in other professions, structural engineers need to begin to communicate with owners on matters of risk.

This paper describes citizen's attitudes using questionnaire results from a basic survey to establish a framework of risk-communication methods with building owners. This survey specifies contents and requirements for risk communication for seismic safety, focusing on the owner's trust of engineers and decision-making for performance. The goal of communication is to make a reasonable selection of seismic safety performance level.

2 CITIZEN'S ATTITUDE SURVEYS

The first citizen's attitudes survey was carried out on the web in 2006 and 535 people's opinions in Japan were obtained. The respondents were men and women more than 30-year-old, who have lived in de-

tached houses in a relatively high seismic hazard area (Tokyo, Hokkaido, and Hyogo).

This survey defines the developing process for citizens with three steps in risk communication (Figure 1). The first step is recognition that risk and information disclosure is needed. The second step is owner's involvement in decision-making and deeper understanding of risks. The third step is rational decision-making of owners supported by structural engineers. For establishing a process of risk communication based on trust, we professionals should understand the current requirement of owners and users and then we have to support owners for decision making and improve owner skill.

A Second survey was carried out on the web in 2008 with 580 citizens. The respondents live in all prefectures in Japan and are from 30 years to 60 years old.

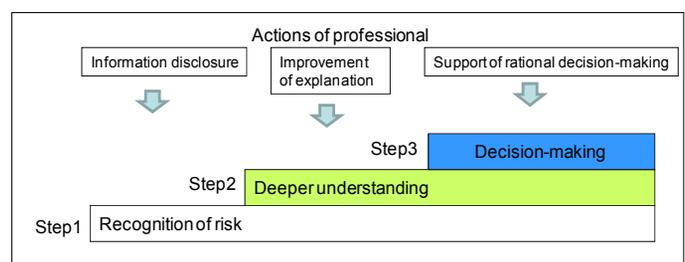


Fig. 1 Building owner's steps in risk communication

3 CITIZEN'S NEEDS FOR RISK COMMUNICATION

Currently, there is almost no discussion of risk communication or probability of failure between building owners and engineers. For deriving general citizen's needs for risk communication concerning structural performance, the first online questionnaire was carried out. The overview is shown in Table 1. All respondents live in detached houses. This is because condominium residents cannot decide structural performances individually, while detached house owners have the possibility to select performance. The living areas of respondents were also selected. Tokyo has the highest seismic risk, Hokkaido has the other risks, and Hyogo had a big earthquake, Kobe Earthquake, in 1995.

Table 1 Outline of the survey

Attribution	No	%
Gender		
Male	284	(53.1%)
Female	251	(46.9%)
Age		
30's	205	(38.3%)
40's	175	(32.7%)
50's	113	(21.1%)
60's	33	(6.2%)
Above 70's	9	(1.7%)
Residential area		
Tokyo	212	(39.6%)
Hokkaido	160	(29.9%)
Hyogo	163	(30.5%)
Age of own home		
Within 5 years	106	(19.8%)
6-10 years	103	(19.3%)
11-15 years	84	(15.7%)
16-20 years	71	(13.3%)
21-25 years	71	(13.3%)
26- years	100	(18.7%)
Experience of earthquake more than JMA 5+ scale		
Yes	191	(35.7%)
No	344	(64.3%)
Home buying experience		
Bought more 10 years ago	175	(32.7%)
3-10 years ago	172	(32.2%)
Within 2 years ago	36	(6.7%)
Will buy within 1 year	4	(0.8%)
Will buy within 3 years	3	(0.6%)
No experience	145	(27.1%)

3.1 Needs of communication and decision-making for a new house

When we asked whether structural engineers could be trusted regarding the current house the respondents are living in, many of them have ambivalent opinions (Figure 2). This is a noteworthy tendency because a fake seismic design scandal happened in 2005, after which the trust of structural engineers was battered. The relative concentration on the ambivalent answer shows that people don't believe professionals and they have a wait-and-see

attitude to trust. The other questions also show the same tendency.

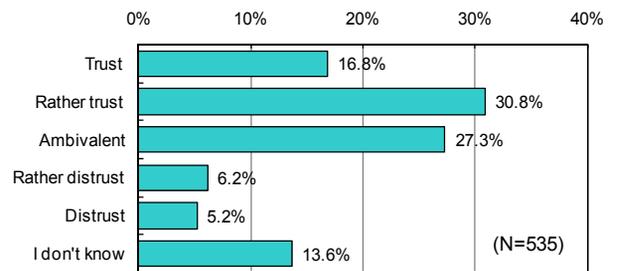


Figure 2 Trust to structural engineer of current respondent's home

The question "if you build or buy a brand new home, do you need to receive an explanation about the hazard of a big earthquake from the structural engineer?" showed a 75% high rate of respondents with willingness to receive that. The need of dialogue in risk communication between home owners and structural engineers is shown in the Figure 3.

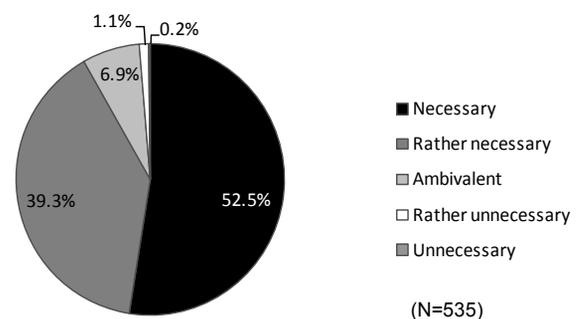


Fig. 3 Need for dialogue on seismic safety with structural engineer

85% of respondents want to decide on the seismic safety level of their future home while supported by engineers.

What is the safety attitude of citizens influenced by? Gender, residential area, experience of a big earthquake and other factors were analyzed. From analysis of the test of independence, these had little influence on citizens' attitude for trust or need of communication. In other words, there was a little difference of living area or experience of big earthquake, or gender.

We asked about the level of understanding of earthquake load as equivalent JMA intensity scale provided in the Building Standard Law of Japan. The relationship of this result and the attitude of whether earthquake load is sufficient for society or not, is shown in the Figure 4. Only a few respondents think that the required load is sufficient. Most respondents were ambivalent, while many felt that the load was not large enough.

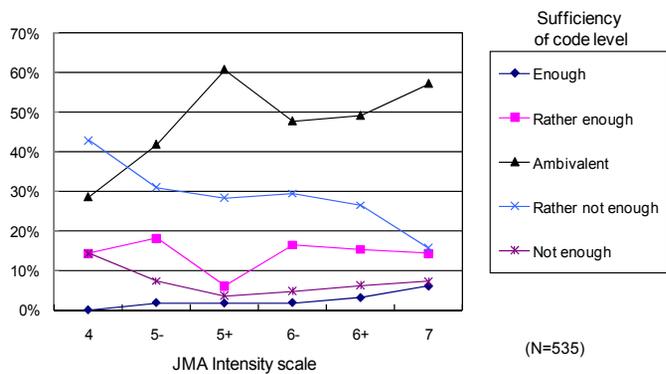


Fig.4 Expected big earthquake scale and understanding of code level

3.2 Which step does the owner stand on?

According to the Figure 1, which defined three steps depending on level of involvement of the owner, we tried to understand on which step citizens are standing. The first step is risk recognition. We focus on citizen's earthquake-scale recognition. In the Figure 5, the result that "if you build or buy a new home, what do you believe is the size and probability of occurrence in 50 years?" is shown by every residential area. Additionally, every area's expected intensity scale on the ground, in the case of 2% and 5% probability of exceedance in 50 years calculated from the earthquake hazard map J-SHIS¹⁾, is indicated by arrows in this figure. Although there is a high rate of undecided respondents, approximate hazard recognition is consistent with expected earthquake intensity.

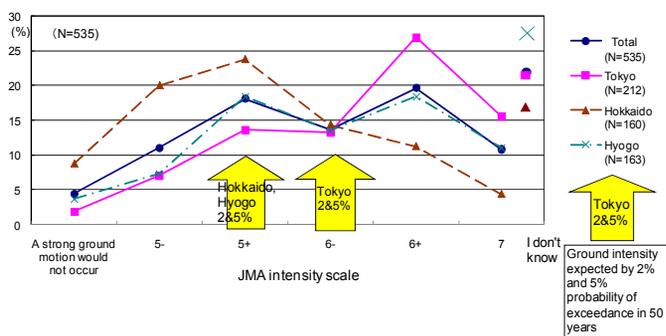


Fig. 5 Expected JMA intensity of respondents and hazard

A higher rate of respondents answered that a bigger earthquake has a chance to occur in Tokyo than the expected intensity. Hyogo has two peaks of answer rate and one peak around 25% fits with the arrow of expected intensity. The mode of the answer in the Hokkaido area agrees with the expected value. Therefore, it is estimated that many citizens understand relatively accurately the earthquake hazard.

The second step of Figure 1 is understanding and involvement. For example, a building owner partici-

pates in decision-making of performance level or an owner tries to understand performance properly from the explanation of the engineer. The structural engineer's effort is required for improvement of explanation skill. By the question "do you want to make a decision about seismic safety level?", the result is shown in Figure 6.

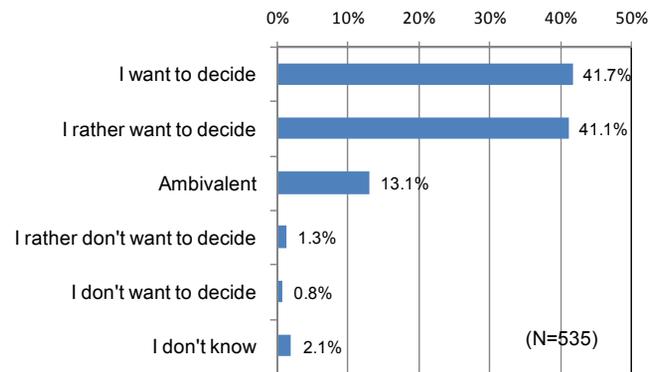


Fig. 6 Need for own decision-making of seismic safety level

The third step is rational decision-making of the building owner. Many respondents have the feeling of participation in the survey but it is estimated owners don't have enough decision-making skill yet. Figure 7 shows demanded seismic safety level that respondents selected for future home. Level 2 and above mean higher level than current code. A majority demand level 3 or 4.

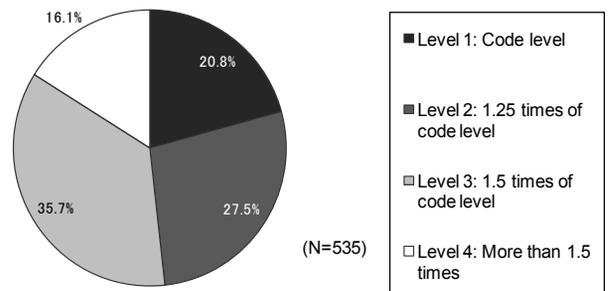


Fig. 7 Requirement of seismic safety level of one's own home

Consequently, while citizen's willingness to involve a decision-making process is high, home owners still don't have enough rational criteria on decision-making of structural performance level or seismic safety level. At this time structural engineers need to ensure better accountability and greater transparency.

3.3 Who is trusted structural engineer from society?

Improvement of the credibility is one of the necessary requirements for success of risk communica-

tion. In this survey, respondents selected requirements for trusted engineer within three options (Figure 8). The most trusted engineer is a person who has rich professional knowledge. In the second place an honest person who communicates both good information and risk is required by 61%. This doesn't mean detailed explanation and time-consuming explanation.

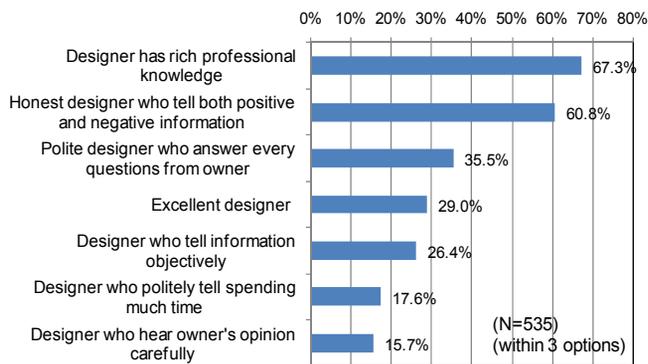


Fig. 8 Required conditions for trust of structural engineers

The next question is “what is the reliable institution to ensure trust in seismic performance of a future home?”, and it is selected within three options. The result is shown in Figure 9. The most required is third-party inspection and next is peer check of structural calculation results at almost the same rate. Around 50% of respondents selected good communication with engineers. As a consequence, third-party certificate and success in communication are required by people.

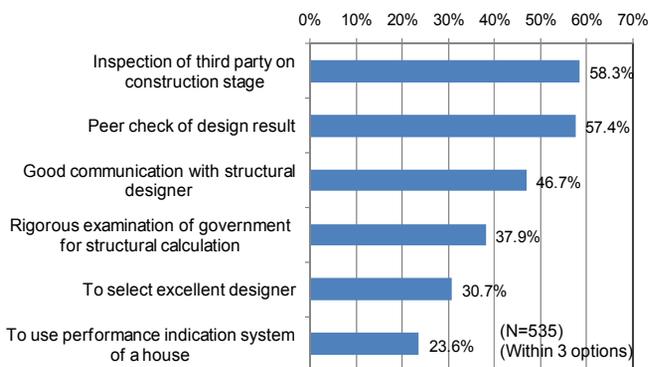


Fig. 9 Trusted systems respondents thought for seismic safety

Meanwhile, Figure 9 shows that not many owners select a time-consuming explanation. Professional engineers are required to lead and enlighten lay public, and to support decision-making and to provide information. They have to have communication skill in order to provide simple and clear explanations. This is a difficult challenge.

4 OPINIONS FOR ESTABLISHMENT OF RISK COMMUNICATION

The internet attitude survey in the spring 2008 went a step further for establishment of risk communication. The overview is Table 2. Conditions to establish communication were questioned in it. Condominium and detached house residents each made up one half of the respondents to determine attitude differences by residence types.

Table 2 Outline of the survey

Month, Year	March 2008
Number	580
Male : Female	302 : 278 (52.1% : 47.9%)
Residential Area	All prefectures of Japan
Age	30's - 60's
Experience above 5+ JMA intensity earthquake	Yes 173 No 407 (29.8% : 70.2%)
Residential type	Detached house 291: Condo. & Apart. 286 Others 3
Questions	* Attribution * Understanding degree of code and earthquake damage * Need for information disclosure * Willingness of dialogue * Need for the way to explain structural performances

4.1 Misunderstanding and its casting aside on structural design

There are some problems that need to be solved for establishment of risk communication. One is that owners don't have correct understanding of structural calculation in general. The responses in Figure 10 show how the respondents understand code level seismic safety. Most respondents understood that code level means sufficient or standard. Just 14% recognized correct code level as minimum. It means that the risk taker, which means an owner, does not have enough information.

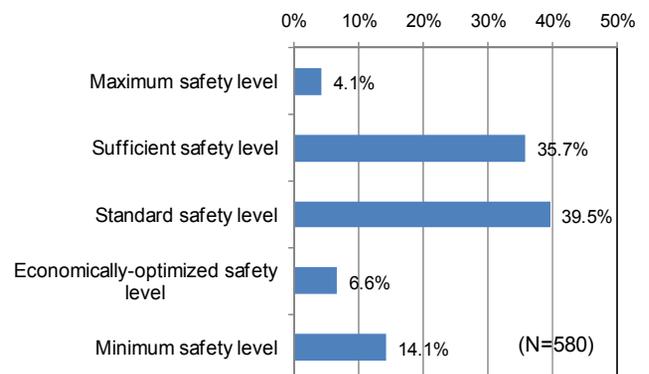


Fig. 10 Understanding of respondents on code level for seismic safety

The factors making it difficult to facilitate dialogue are not only difficult content, but also citizens have lack of interest or knowledge for structural

safety. Problem-solving training is needed for citizenship education. However, it is inefficient and time consuming. The more efficient way is an explanation by the engineer in each building design. Respondents also have the misunderstanding that many condominium developers establish clear consensus of structural performance with structural engineers.

4.2 Owner actions in time of confirmation of structural performance

From the question about action that respondents wish to confirm of the purchase, there are just a few people who are content to satisfy code level or who leave it entirely up to engineers. Most respondents preferred the various actions as listed in Fig. 11.

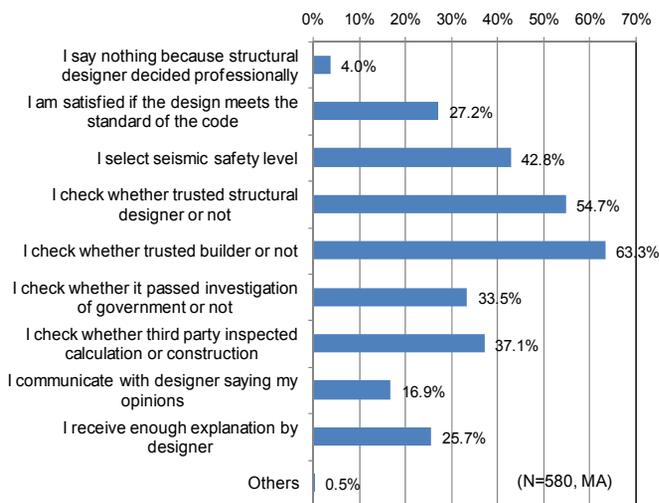


Fig. 11 Owner's measure on seismic safety of the purchase of new home

4.3 Requirements for information disclosure of structural performances of the purchase of home

The rate that people require explanation about structural performances is high. Significantly, more than half of respondents consider that information disclosure on structural performances is not enough in the purchase of their home at present (Figure 12). Deficient information is shown in Figure 13. The result shows that respondents feel that there is no or little information about ground, piles, or material strength when they buy a brand new home. They also think that information about seismic isolation or damping is not sufficient. Meanwhile, information about isolation or material strength is already realized in the brochures for many new condominiums.

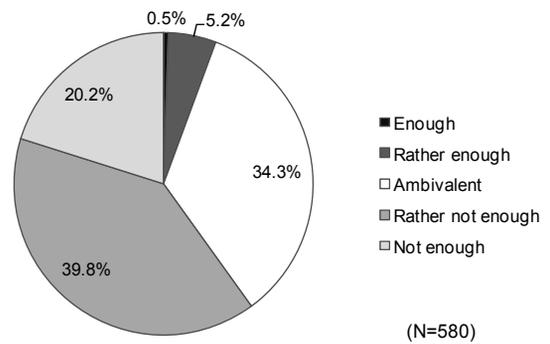


Fig. 12 Information disclosure of the purchase of the new home

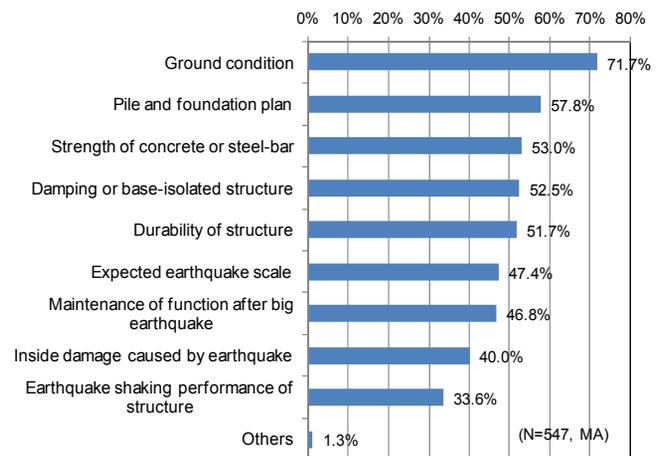


Fig. 13 Deficient information which owners feel

The explanation of performances before the agreement is especially needed (Figure 14). Also need of risk communication is extremely high (Figure 15). Owners need preliminary explanation and communication.

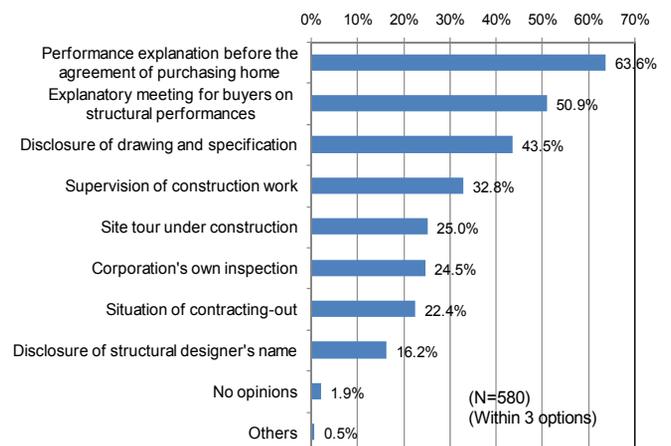


Fig. 14 Important information disclosure for trust

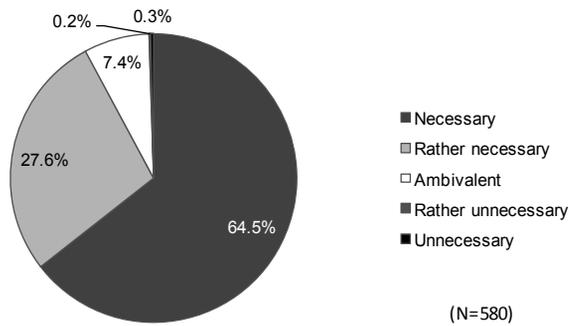


Fig.15 Risk communication need

5 RELATIONSHIP BETWEEN OWNER'S TYPE AND DIALOGUE REQUIREMENT

We consider what kind of owner requires dialogue with engineer. The relationship is analyzed using the chi-square test. Very few answers were negative for risk communication and then answers "positive, relatively positive, or ambivalent", excepting "negative, or relatively negative", were analyzed.

Respondents evaluated themselves as capable of studying independently, but most of them have a lack of decision-making capacity. Professionals should lead owners who lack the skill of decision-making with understanding from the second step (explanation) to the third step (decision making) of risk communication. At present, detailed decision of seismic safety by owners is not required, but they need adequate explanation and then information sharing of the parties.

We asked what seismic safety level is required for a home representing several levels like Figure 7. We found a positive association between wish of high quality and dialogue requirement. The higher the quality respondents wish to have, the more dialogue ($p < 0.05$) or confirmation ($p < 0.01$) by the owner is needed (Figure 16).

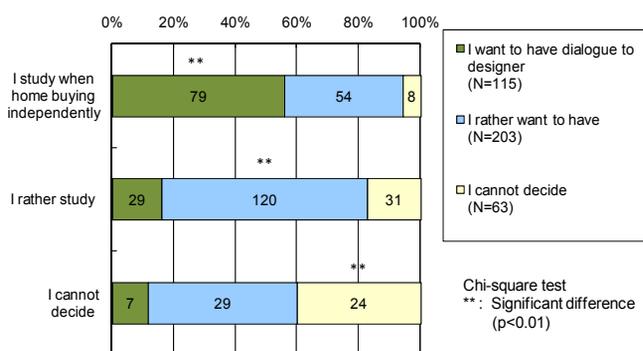


Fig. 16 Need for dialogue to engineer by owner types

The type of owner who collects much information ($p < 0.01$) about home or who studies independently has relevance to dialogue need. Also there is relevance between people who wish to hear much information and whether they feel dearth of information at present or not. It will be more important for structural engineers to provide more information about performance to owners who wish to know or study.

Therefore, if a home buyer who has willingness to achieve a higher seismic safety level, adequate explanation and dialogue will be efficient and necessary.

6 ACTUAL STATE AND FUTURE TASKS FOR ADVANCE OF RISK COMMUNICATION

What is necessary to establish risk communication method? A preceding study²⁾, focusing on trust factor, pointed out trust and involvement would be the key point to make change from concern to relief of people (Figure 17).

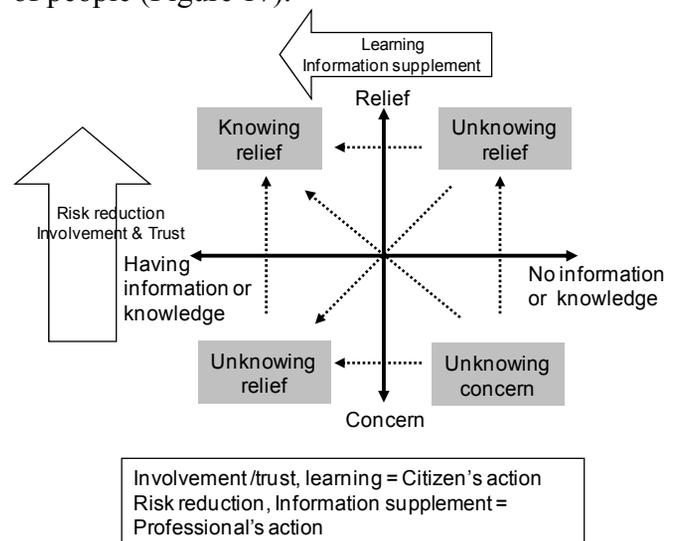


Fig. 17 Scheme of reassurance²⁾

By putting our result on top of this previous research, a higher rate of respondents feels a dearth of information at present. When we replace satisfaction in quality of seismic design by concern/relief in Fig.17, concern type is the largest number, which type doesn't trust quality of seismic design yet (Figure 18). This corresponds to unknowing concern type of previous literature²⁾ roughly. Firstly we have to make change of citizens from unknowing type to knowing type by informing, and to make change from concern to relief. Study by owners or information supplemented by professionals is necessary for this. In the case of seismic performance decision-making, professional information is a key, and professionals have to carry out concrete measures for improvement of trust. Consequently structural engi-

neers will be responsible in two ways, ensuring trust and involvement of owners in decision-making.

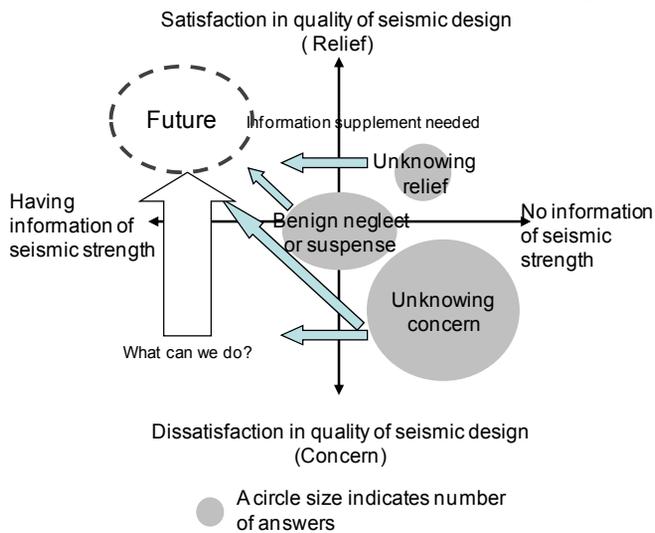


Fig. 18 Result of this survey about pursuit of reassurance

7 CONCLUSIONS

Deriving from two attitude surveys, we considered there was difference of need for dialogue depending on owner types. The best timing for risk communication is for it to take place before the agreement for the design. Although they require honest engineers, 67% of them will cancel a buying decision when they hear their house risk from the engineer. Information disclosure should be cautious approach. First, Avoidance of misunderstanding is so important that the academy, which can take a neutral position, should help to convey information by standing between professionals and owners.

In the case of explanation of performances before buying, too much information prevents, rather than enhances, understanding. Adequate information volume is needed. Given the background that there has been little information for home owners, information disclosure must be carefully improved

The respondents are so interested in risk communication, and they need not a commentary but explanation of the engineer. The explanation of performances before the agreement is especially needed.

Risk communication is essential to owners but it is also difficult under present circumstances. We conclude that current better solutions for risk communication could be the achievement of sufficient and comprehensible explanations by structural engineers using explanatory materials and help by the academy.

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