Proposal of Effective Quality Control and Insurance System of Construction Industry

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***ABSTRACT*:** In this research, the kinds and the number of defective qualities are examined, and the current state of the defective quality is understood. In addition, a social cost led by analyzing the quality control cost function and the quality insurance cost function in making optimal balance, and requesting a total cost are analyzed. The insurance system that adds the parameter of citizen's senses of trust at the end leading to an ideal social cost in evaluating the optimal construction management level is introduced.

KEYWORDS: management of effective quality control, construction of insurance system

1. INTRODUCTION

The quality issue in the construction industry of Japan becomes a big problem with the regards of the design and execution management. The problem of construction defect with large social influence level has decreased people's reliance, and has come to influence the house purchase.

The system of the quality control of the design and construction greatly lays a background for the issue mentioned above. It comes in construction management system and industrial system that relies on mutual trust does not always succeed.

Moreover, a major factor to decrease the quality is reduction in number of engineers at the construction site as well as engineers in the administration that civil servant reduction rate fixed regardless of the influences of the system.

It is thought that it is necessary to review the ideal way of the quality control again. On the other hand, the defective quality (construction defect) is a problem existing for a long time, and it is almost impossible to eliminate the defect completely. Since it is not possible to imagine a defect free project, it is essential to develop appropriate quality control (inspection of construction process) system for minimizing the defects in a project.

In the idea of the quality control system, it is necessary to read the quality control from the aspect of the entire construction industry in an individual building. The optimal quality control level or construction management system is found from the economy in which both sides of the quality control cost and the defective quality repair cost are considered in an individual building. At the same time, it is required to correspond to the defective quality that has occurred because it constructs the insurance system that secures the processing cost to the defective quality from the aspect of constructing industry-wide.

2. QUALITY CONTROL IN INDIVIDUAL BUILDING

2.1 Basic Policy

In the quality control in an individual building, grasping of problem in quality control in relation to

the management is required. Then, the classification of the problems and their inter-relations are needed to be clarified.

The feature and the rule of the defective quality (quality of design, construction quality, equipment quality, and material quality) are evaluated. Next, the defective quality is systematized according to the stage. This is assumed to be a cause and effect diagram.

And, it is divided into the various classification and the items. The total cost needed for the processing after the number of defective qualities is examined and is shown as a Pareto chart.

The structure of the quality control level is designed from the amount of loss by the cause of the defective quality. And, the quality control level and the content are decided. Then, the priority level of management at the construction stage to achieve a fixed defective quality rate is decided.

The data that relates to an actual inspection of construction process is needed in this process.

2.2 Methodology

2.2.1 Investigation of rate of defective construction

The content and the factor of the defective quality by the data of quality related to construction like faulty workmanship and improper work are specified. The relation between the content of the inspection of construction process and the quality of the result is analyzed.

At the beginning, the analysis of the quality control problems based on the defective consultation annual report was done. About 20,000 (For five years) factors were presumed.

Moreover, because only the consultation annual report doesn't necessarily clearly show the number of actual defective qualities, interview was executed.

Number of defective housing is possibly ten times as much as counted by an interview.

Consequently, the number of defective quality is 40,000 during a year. And, about 400,000 houses are being built in a year.

The defective housing rate is a probability of approximately 10%.

2.2.2 Systematization of defective quality

The defective quality is classified into the quality of design, the construction quality, the equipment quality, and the material quality by grasping the defective quality (construction) obtained in the above-mentioned. And, the cause and effect diagram is made by specifying and systematizing a concrete item. In this text, it is very important to derive the factor of the defective quality and the result from it.

Systematization classifies the defective quality into four (the design, construction, and equipment and the material) as shown in Figure-1, and marks down the defective quality item at each stage. In Figure-1, the stage of the design, construction, equipment, and the material is divided into the factor of 22 all together.

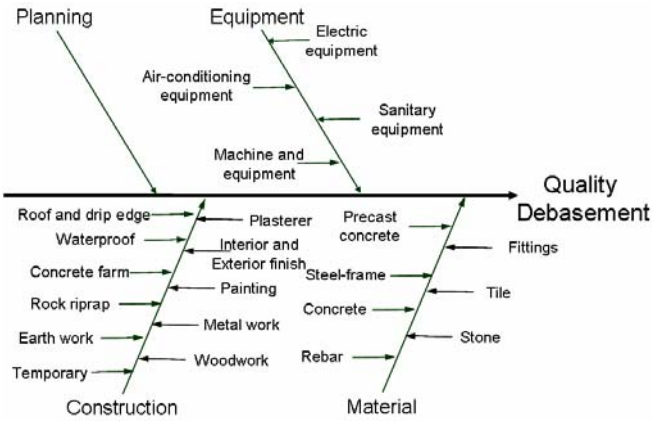

Figure-1: Systematization of defective quality

2.2.3 Renovation cost upon occurrence of defective construction

A Pareto chart consisting is the defective quality along transverse axis and, repair cost in the vertical axis is shown in figure 2.

The repair cost of each defective factor is calculated

for all potential defective housing.

The repair cost (Price of material, cost of labor, machine apparatus expense, hypothesis material expense, haulage costs, and market unit price, etc.) of each defect trouble is quantified. It was classified according to the factor of the defective quality.

In Figure-2, the repair cost of each item according to the factor is shown. Moreover, it is concrete that repair cost of the defective quality regarding a rebar, concrete, concrete form; a plasterer is high.

Thus, it confirms the importance degree of which requires high quality control. And, basic information can be arranged.

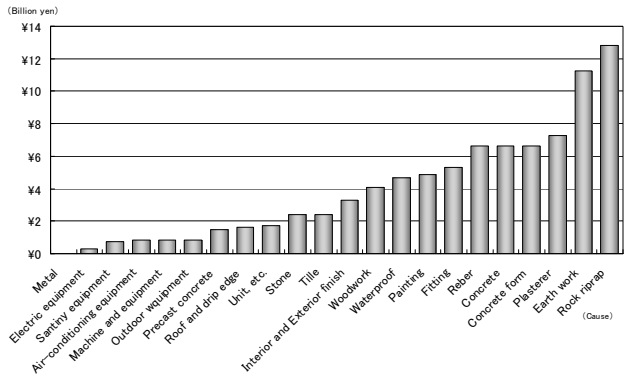

Figure-2: Total renovation cost of each defect

2.3 Quality control in individual building

The quality control item according to the item classification and the necessity of the importance degree can be confirmed in an individual process (quality of design, construction quality, equipment quality, and material quality) from the above discussion. And, it is possible to tie to the establishment of the construction management system for the improvement of the major items of the repair cost and to decrease the generation of the defective quality.

3. QUALITY CONTROL IN THE CONSTRUCTION INDUSTRY

3.1 Basic Policy

The quality control in the construction industry is thought that the design of the most efficient quality control system minimizing the total of both the quality control cost and the quality security cost becomes possible. In a word, the optimal point at the quality control level is derived by selecting a minimum point of a total cost or a social cost. The construction management level at the level corresponding to the defective quality item of Figure-2 corresponding to the optimal cost can be set.

3.2 Methodology

3.2.1 Quality control (Inspect of process) cost and quality insurance (Accumulated repair) cost

The optimization of the quality control system and the insurance system is obtained by deriving the quality control cost function and the quality insurance cost function. The quality control cost function is obtained by making a function to the cost needed according to the construction management level when the defective quality is prevented through the inspection of construction process.

On the other hand, it thinks the quality insurance cost is calculated in the form of insurance. In a word, the quality insurance cost function is derived according to the cost needed to process the defective quality. It is assumed that insurance (rate) corresponding to the defective quality rate.

The amount of money that requires to make amendments by calculating a defective rate at which all buildings of targeting and each construction management level of insurance in Japan that cannot be evaded can be calculated by using Figure-2, and the quality insurance cost function is derived.

3.2.2 Deriving of quality (repair) insurance cost

The quality insurance cost can be derived by requesting the accumulation cost from the one whose

repair cost is lower than the Pareto chart (Figure-2).

The total of the repair cost of all the defective qualities becomes 86.6 billion yen.

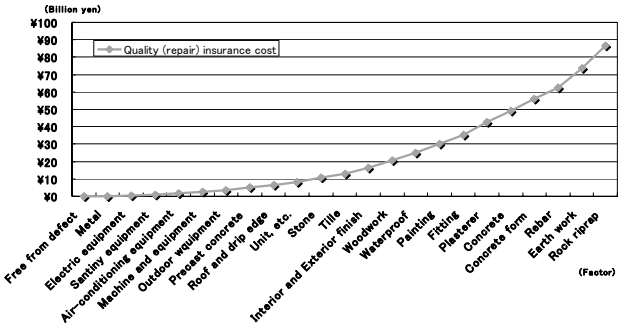

Figure-3: Quality (repair) insurance cost

3.2.3 Derivation of quality (construction) control cost

The quality control cost (Inspection cost of construction process) is calculated for the house (Architectural expense: about 20 million yen) of the RC structure.

A typical work schedule is made from the construction chart below. The inspection cost is calculated from a necessary number of engineers. In this case, third party inspector is expected to cost 20,000 yen per day.

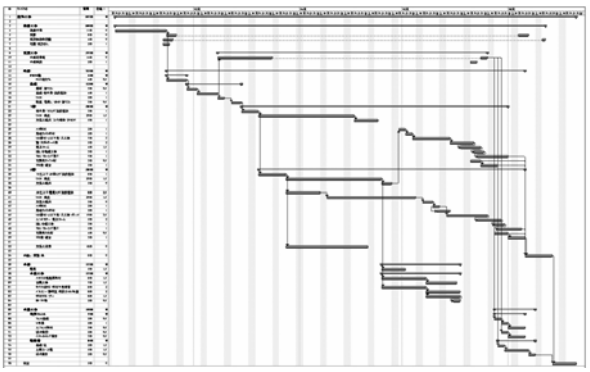

Figure-4: Management arrangement in typical work schedule

Next, the required maintenance fee of each factor of Figure-1(labor cost) was distributed, and the total amount of money of the factor was derived.

Quality (construction) control cost becomes 725,000 yen (Inspection cost per total construction cost, 3.6%) per household when all quality controls are executed, and quality (construction) control cost during year becomes 290 billion yen. (Figure-5)

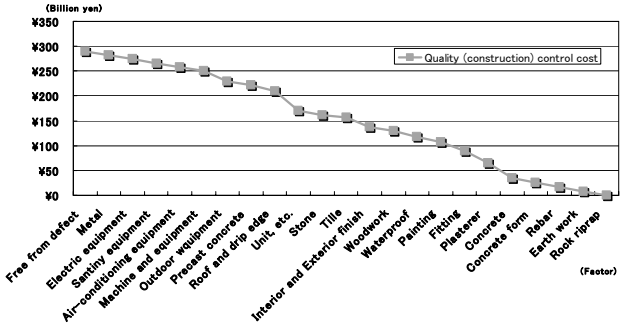

Figure-5: Quality (construction) control cost

3.2.4 Derivation of social cost

The total cost function that can be calculated by the sum total of the quality control cost (cost to make amendments for defective quality) and the quality insurance cost (construction management level corresponding to defective rate) is obtained from the quality control cost function and the quality insurance cost function.

This is a social cost that requires it to secure the quality of the building under consideration. It is thought that minimization point would offer most economical & reasonable quality control system. It becomes basic of a social system design to which the sum total of insurance in the insurance system based on a defective rate corresponding to the quality control cost corresponding to the construction management level and is minimized. (Figure-6)

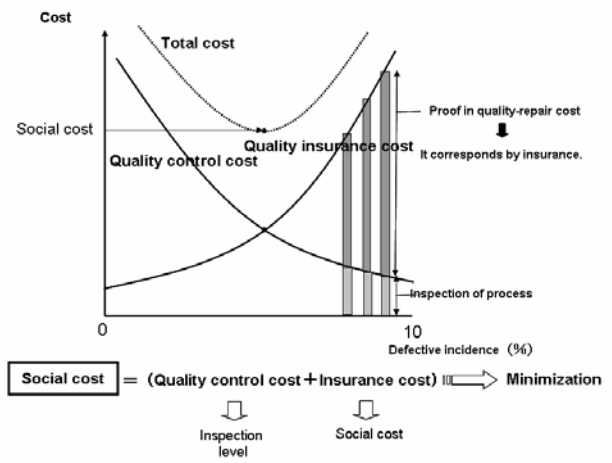

Figure-6: Social cost structure for quality securing

And it is preferable to minimize a social cost. Minimizing a social cost from Figure-7 becomes the part of the rebar. At this time, rock riprap and earth work defects are controlled by the inspection of construction process.

And cover everything from the rebar to the metal as insurance. It becomes the optimal social system in this case as a construction management level.

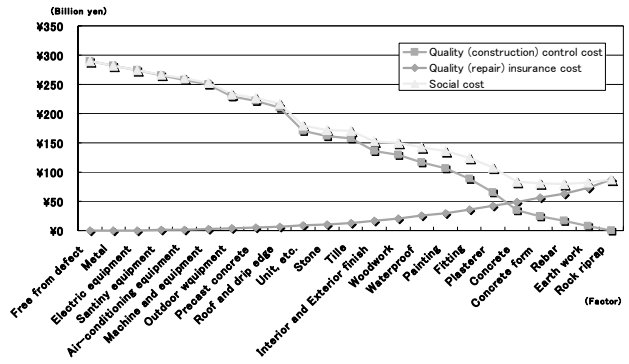

Figure-7: Social cost

3.2.5 Relation between construction scale and social cost optimal point

It is thought that the relation between the quality control cost and the quality insurance cost changes by the difference of the investment scale of the building, and the movement of optimal point of a social cost.

The quality control cost to the construction expense lowers relatively when a construction scale ups. And the optimal point of a social cost moves in the direction where a defective rate lowers.

In the design of the insurance system, when we set insurance corresponding to the construction scale, when the premium rate is made constant by leveling regardless of the construction scale, it is necessary to examine which is a good social system.

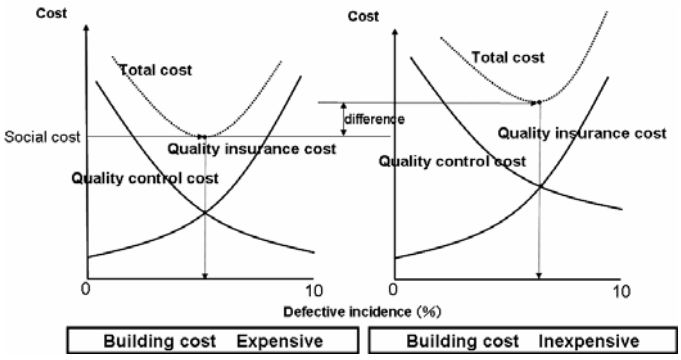

Figure-8: Changing of optimal point of social cost according to construction scale

3.2.6 Citizen's senses of trust

It is thought that citizen's senses of trust to the construction industry are socially the critical factors, and is necessary to consider it in designing quality (construction) management system and insurance system.

Citizen's senses of trust quantitatively grasp people's anxieties to the defective quality. And it is necessary to make trust to the function to compare it at the same level as quality (construction) control cost and quality insurance costs. After that, the minimum point of a total cost including citizen's senses of trust can be derived by subtracting it from a social cost.

A social cost is a negative factor, and citizen's senses of trust become possible by deriving the optimal point by pulling the latter from the former because it is a positive factor. (Figure-9)

A social cost is in increasing direction though it becomes important to be as small as possible, a defective rate from people's aspects. It is important to set the tolerable quantity related to the increase of

a social cost by considering citizen’s senses of trust.

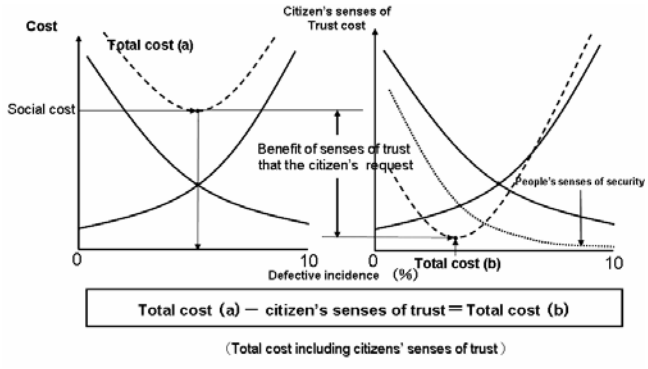

Figure-9: Relation between citizen’s senses of trust and social cost

It is necessary to request the amount of money from the quantification of citizen’s senses of trust that generates corresponding to the level of the defect (heavily, moderate, and slightly) and the people to the evasion of defects.

It is a defect of 30 million yen or less in the repair cost including the subsidence etc., and the incidence of a heavy defect becomes 0.6%.

It is a defect of five million yen or less in the repair cost including the inclination etc., and the incidence of a moderate defect becomes 1.2%.

It is a defect of 500,000 yen or less in the contained repair cost including the leaking of rain etc., and the incidence of a slight defect becomes 8.2%.

The repetition part has been generated in the range of the defect, for instance a serious defect in a basic part is contained from the crack if it is concrete.

Here, it questioned about hearing to quantify citizen’s senses of trust. It listened how much would be able to be paid to evade each defect (heavily, moderate, and slightly) from the content of the questionnaire.

As a result, it is 180,000 yen a person for a heavy defect, 80,000 yen for a moderate defect, It is approximately 40,000 yen that a householder is willing to pay was obtained.

It is assumed that the total of citizen’ senses of trust by showing this by 400,000 households' is accumulating in a year.

3.2.7 Social cost including citizen’s senses of trust

The preferable construction management level finally requested has the necessity including convenience of not a simple, social cost but citizen’s senses of trust. Therefore, it leads to the decision of the optimal construction management level by which citizen’s senses of trust are considered by adding to a social cost in which the sense of trust of the requested people is previously derived. Citizen’s senses of trust are added, and then, social cost decreases greatly from the reinforced concrete, and consequently social cost, and the optimal construction management level is minimized in the plasterer part as shown in the following Figure-10.

As a result, managing everything from ground work to concrete in the inspection of construction process, and adjusting from the plasterer to the metal by insurance become the optimal.

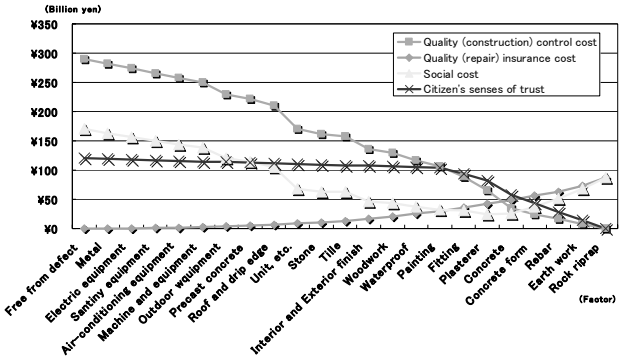

Figure-10: Social cost including citizen’s senses of trust

3.3 Quality control system in construction industry

The optimal construction management level by which the social influence related to the quality securing can be decided by adding the index of citizen’s senses of trust as a social benefit. It is thought that the demand level changes depending on the used period and the investment scale of the

building. Generally, it is guessed that the demand level rises by these indices in large. Moreover, it is thought that the demand level of the sense of trust is also different in the building etc. that the corporation buys the office building and the individual buy the house. Making the social benefit of function in which these are assumed to be a variable is needed.

It is necessary to design the insurance system according to the optimal construction management level by which citizen's senses of trust are considered as a social benefit.

About the improvement of all the defective qualities though it is impossible, higher cost and longer time are required for the improvement of the quality control system. Therefore, it is reasonable to pay the one with a low repair cost by the quality insurance cost (insurance). It is not done as the object of quality (construction) management system. Applying the quality control concept similar to factory products by introducing insurance becomes possible though factory products are the job-order production of the different article.

In the insurance system, the client consists of the payment of the repair cost corresponding to the generation ratio of the defective quality corresponding to the construction management level. Fair insurance (insurance rate fee equal to the expected value of damage) will be collected in the insurance mathematical principle. However, the frequency and neither scale nor the repair cost is made public as required for the defective quality. Basic date of the setting of insurance should be made data base according to the kind and the scale of the building.

4. CONCLUSION

In this research, decision of construction management level to minimize social cost, construction of insurance system to minimize social cost and to fill reliance that the people request becomes possible.

A heavy defect and the moderate defect can be controlled in the inspection of construction process by the third party, and the construction control cost of a household becomes 162,500 yen if it thinks at the construction management level of the case including citizen's senses of trust.

And, about 42.6 billion yen is dropped below in 400,000 households, counted from the calculation of the total of the generated repair cost according to the division process by the number of housing, and it becomes 106,535 yen a household for insurance.

Consequently, it is assumed that the construction management level and the insurance system be made an obligation.

And, the construction control cost is be responsibility and adoption of client side, insurance is assumed for the constructor, the system that proposes it by paying about 300,000 yen (The ratio to architectural expense is 1.5 %.) per housing. The construction system and insurance are greatly ameliorable.

If Insurance is paid by constructors, ranking system based in their records is necessary to set suitable insurance rate.

The quality control system based on a proper level of control of construction intended for the entire building in Japan and the insurance system can be designed best by using a social cost in which the social convenience function related to quality control cost function proposes by this research, quality insurance cost function, and citizen's senses of trust is totaled.

The level of control of construction demand from the building in Japan is requested by deriving each cost function by doing people's demand for the defective quality rate and the sense of trust in

marketing.

It is possible to recover the trust of the construction industry by applying the above mentioned method of the construction management level proposed by this study and the insurance system in various buildings or constructing industry in the future.

REFERENCES

Sadakazu, ANDOU, Yoshitaka,MATSUMURA, 1981. *Introduction to statistical quality control for engineer, Kyoritu.*

Yuichi, TATANA, Yoshirou, TAKAGI, 2005. *Diagnosis of the economy of disaster prevention Measure and evaluation of risk management, Keisou.*

Housing reform ・Dispute processing support center,2004. *Consultation statistics annual report 2004, Kaisei.*

Housing reform ・Dispute processing support center,2005. *Consultation statistics annual report 2005, Kaisei.*

Yasunori, MATSUFUJI, Hiroshi, NAKAMURA, 2003. *Architectural construction ・Management, Asakura.*

RIBC Research Institute on Building Cost, 2006. *Multiplication manual of public, architectural repair work, Taisei.*