JSEC Task Committee 336 on "Reliability-Based Design of Concrete Structures"

SCOPE

The need to replace conventional methods with performance-based design is well recognized. As performance-based design has come into use around the world, reliability theory will be used for the seismic safety or durability evaluation of concrete structures, ensuring that uncertainties in design variables (such as variability in material properties and the accuracy of structural analysis) is taken into account. As a result, an assured level of safety will be realized by reducing the probability of undesirable outcomes (referred to as the failure probability) below a target value (referred to as the target failure probability). By employing the concept of a failure probability in this way, it will be possible to quantitatively evaluate the safety of a structure. Above all, this design method enables one to maintain a firm grasp on the safety level desired, and to design a structure so as to realize this prescribed reliability independently of other design requirements.

The JSCE task committee 336 on “Reliability-Based Design of Concrete Structures” (Chair: Prof. M. Suzuki, Tohoku University) was established in 2006. The objectives of the activities of the committee are to investigate the techniques for introducing reliability-based design into design codes for concrete structures in Japan and, to present the practical examples of seismic safety or durability evaluation for concrete structures based on the reliability theory.

WORKING GROUP

The task committee consisted of two working groups, as follows:
WG1: Reliability-based seismic design
WG2: Reliability-based durability design

AIM OF THE WORKING GROUP WG1

The term "seismic probabilistic risk assessment" is usually reserved for the comparison of criteria of risk acceptability for the estimated risk of a structure in relation to potential future earthquakes, taking into account the variability and uncertainty in earthquake occurrence, seismic ground motions, the resulting behaviors of structures, etc. The estimated risk in the seismic probabilistic risk assessment is presented as an annual probability of exceedance of the damage state.

A seismic risk assessment problem is disaggregated into two probabilistic analyses, i.e., of hazard and fragility. WG1 shows how to calculate the hazard as well as the fragility curves of concrete structures against earthquakes. In addition, this WG presents a simplified method of probabilistic risk assessment using the public seismic hazard curve on Internet webpage created by J-SHIS (Japan Seismic Hazard Information Station). Because it may be very difficult for concrete engineers to calculate the seismic hazard curve, this method will be used extensively for seismic probabilistic risk assessment of concrete structures.

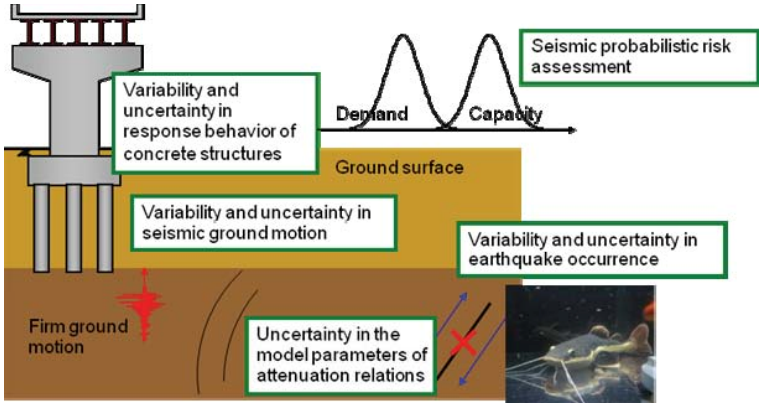

Figure 1. Variability and Uncertainty in Seismic Probabilistic Risk Assessment

WG2

Many environmental factors affect the degradation mechanisms of materials, but their precise influence is difficult to predict due to great local variations. In addition, the properties of the materials themselves may vary substantially. Because of these and other factors causing increased scatter, the performance and service life of a structure should preferably be treated stochastically. This means that not only average values, but also distributions, are considered. Probabilistic treatment of design problems takes into account the real nature of structural performance, making possible reliable structure design.

The aim of the WG2 has been to work out the theoretical background and the design procedure of the durability design of concrete structures and to present a selection of durability models that are suited to reliability-based design.

Additionally, the aim was to present some examples of practical durability design. When performing a probabilistic assessment of the reliability of deteriorating existing structures, we often can obtain the results of inspections in time, within the models used to analyze the progress of deterioration. As such, some probabilistic parameters used in the deterioration model can be modified and the relationships between the reliability index for durability of concrete structures and service life can also be updated. We will provide practical examples of reliability-based durability evaluation for concrete structures utilizing the inspections results.

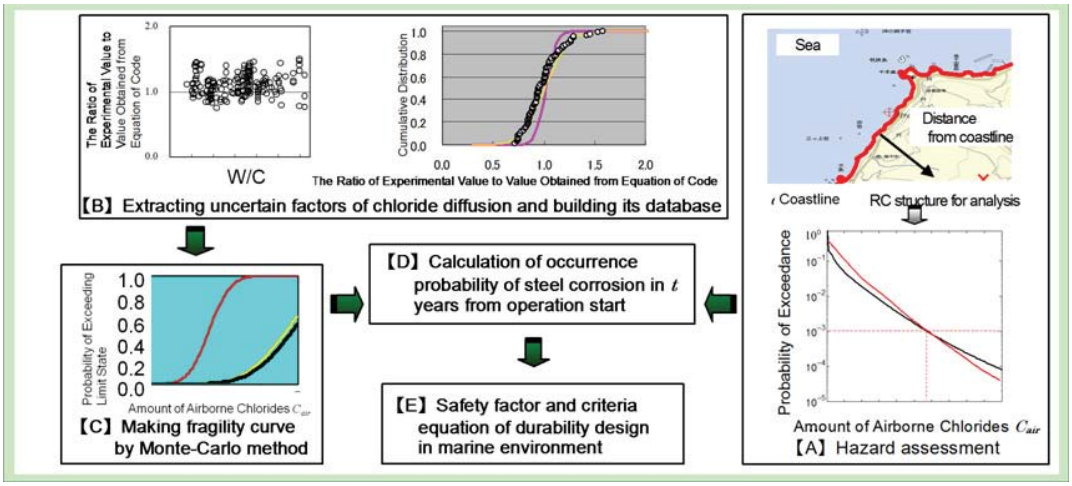

Figure 2. Flowchart of Calculating Safety Factors Used in Durability Design of Concrete Structures

ACTIVITIES

The JSCE Task Committee 336 started its work in August 2006 with 32 members and will finish at the end of October 2008. The report of its activities will be published in December 2008 in Japanese.