論文の内容の要旨

Abstract of Dissertation

Title of Dissertation: STAGNATION OF LIQUID WATER/ CHLORIDE ION PENETRATION IN CONCRETE AND APPLICATION OF THE KNOWLEDGE TO DURABILITY DESIGN AND LCC

（コンクリートへの塩分および液状水の浸透停滞現象と耐久設計
および LCC への導入）

Author: ISLAM Md. Shafiqul

イスラム　モハメッド　シャフィクル

Service life estimation of RC structure depends on the accuracy of prediction of deterioration. Out of many causes of deterioration Corrosion of reinforcing bar due to salt attack is one of the major deterioration phenomenons for RC structure. Chloride at the surface of steel bar initiates the corrosion of steel embedded inside concrete. Expansion of steel occurs by corrosion products that creates tremendous pressure at surrounding concrete and crack generates. Finally the safety and serviceability of the structure has to face the question.

All the previous models, to predict chloride penetration, take the Fick's law as the basis of computation. According to this law, chloride will penetrate as the time goes on and on, that means no limitation of depth of penetration. This does not support the penetration behavior in some cases of really durable concrete structure. Current durability design based on Fick's law, specified by JSCE, overestimates the cover size of concrete while the concrete quality is very good. Adopting always Fick's law for good quality of concrete makes uneconomical and irrational design where steel may yields fast and can generate problems against safety and serviceability of RC structure.

Recent findings from the inspection data of a bank protection structure constructed in Okinawa suggests that the depth of chloride ion penetration is limited to certain depth although the chloride profile was measured at different ages of 1.5, 3.5 and 8.75 years which is similar to the depth of saturation front. This observation was found in Fly ash concrete which was very good in case of cover resistivity. Another type of medium grade concrete was inspected for chloride profiling from the same structure of Okinawa. This concrete explored that not only the penetration front but also its variation around the mean depth is an important parameter to be taken into account for service life prediction. Now it is important to modify Fick's law by the inclusion of limited depth of penetration coupling with the mean and variation of depth of water front

An attempt was given to predict relationship among parameters by experiments to quantify liquid water front. w/c ratio were varied as 40%, 55% and 70% to visualize good, medium and bad types of concrete. Specimens containing 70% of w/c ratio showed good agreement for chloride profiling with that analyzed by Fick law.

Based on above findings from inspection and experiments, a classification of analysis method is proposed that should be applied depending on the type of concrete. At the design stage, quality of concrete is judged by its mix proportion while for the existing structure w/c ratio becomes just a reference value and the performance of concrete cover is influenced by construction process. Thus the criterion for judgment of quality of cover concrete should be different for the structure prior and post construction process. In this context, w/c ratio and torrent permeability are set to be criterion to choose suitable methods of analysis for new and existing structures respectively.

Accuracy of service life prediction largely influence life cycle cost of infrastructure. In current days, a lot of money is investing for the rehabilitation of infrastructure like bridges by the government in every country. However, the cost of maintaining the infrastructure is

increasing significantly all over the world, that throw challenges to the engineers, businessmen and the infrastructure managers to have cost effective decision on maintenance planning that can save huge amount of expenditure. Maintenance planning includes all the costs such as initial construction cost, user cost, inspection cost and repair cost expended throughout the lifetime of the infrastructure. This whole scenario can well be reflected by Life Cycle Cost (LCC) analysis. Regarding precise prediction of LCC, practical engineers do not agree with the calculation done by desk researchers. The cost do not match between the image of LCC done by top most engineers who are concerned about the durability of structure and the researcher who calculate LCC based on Fick law. It is proved in this research that adoption of the proper method based on type of concrete can synchronizes the LCC supposed by engineers with that of desk researchers.

It is well known that cover size can be treated as fundamental parameter to make barrier against foreign matter ingress. Thus safe cover design was done as application of LCC based on water penetration front.

Finally a comprehensive framework is developed which includes the liquid water front and variation as cover resistance parameters where proposed analysis methods can be used depending on the quality of cover concrete and subsequent LCC can be computed.