【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Long-Term Dynamic Simulation of Large-Scale RC-PC Infrastructures Based on Quasi Thermo-hygro Modeling

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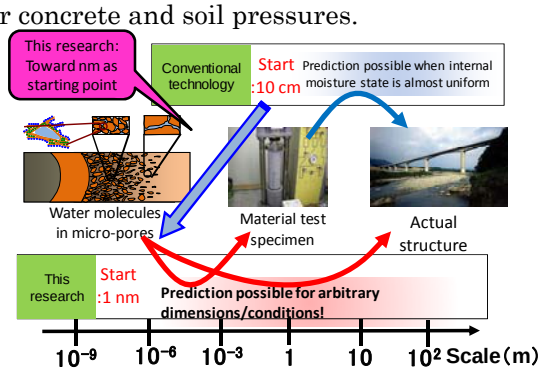
Research Area : Civil Engineering, Construction / Material / Management
Keyword : Concrete Engineering

【Purpose and Background of the Research】

The aim of this research is to develop a simulation technology for long-term kinematics of large-scale RC-PC infrastructures subjected to environmental actions and external loads, based on multi-scale analysis that satisfies the quasi-equilibrium states of moisture in micro-pores of cementitious composites and varying macroscopic momentum in time and 3D space. This research is directed at determining the leading causes of long-term excessive deflection of long-span bridge viaducts and the medium-term excessive deflection of shallow underground structures, which are risk issues of worldwide interest. Through this approach, it is aimed to rebuild the limit state design scheme for concrete and soil pressures.

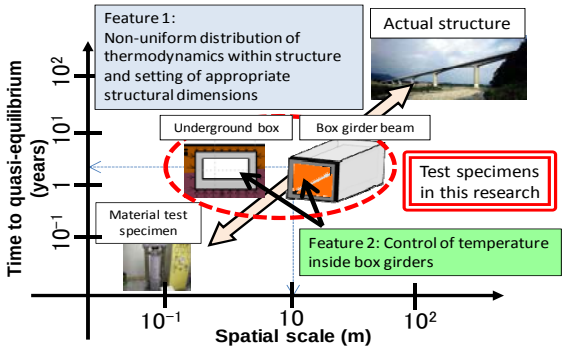


Framework of this research

【Research Methods】

The thermodynamic states of small-scale specimens, on which conventional creep analysis method is based, reach equilibrium with ambient states in a short period. However, in actual structures, non-uniform thermo-hygro states persist for a long time and this is likely to cause excessive deflection of long-span bridges. This research targets medium-scale structural concrete which may retain non-uniform thermo-hygro conditions but converge to the hygro-equilibrium within a couple of years.

Experimental verification of the multi-scale thermo-hygro analysis will be conducted by reproducing the high gradient of vapor pressure in micro-pores caused by fluctuating temperature and humidity inside the specimen.



Features of experimental method

The experimentally produced profile produced through the accelerated simulation and attainment of equilibrium states in specimens may allow prediction of excessive deformation phenomena that take place over hundreds of years in actual structures of large sizes.

【Expected Research Achievements and Scientific Significance】

Conventional methods may not adequately simulate the long-term kinematics of medium-scale structures because of the gap between assumption and reality of local moisture states. In this project, the strict thermo-dynamic multi-scale simulation is attempted in consideration of moisture migration and its state equilibrium for control of long-term deformation of large-scale concrete structures. These results will be applicable to maintenance in practice, risk assessment of existing structures, and preventive countermeasures.

【Publications Relevant to the Project】

- Maekawa, K., Ishida, T. and Kishi, T.: Multi-scale Modeling of Structural Concrete : Taylor & Francis, 2009
- Maekawa, K., Chijiwa, N. and Ishida, T. : Long-term deformational simulation of PC bridges based on the thermo-hygro model of micro-pores in cementitious composites, Cement and Concrete Research, 2011

【Term of Project】 FY2011-2015
【Budget Allocation】 172, 800 Thousand Yen
【Homepage Address and Other Contact Information】
http://concrete.t.u-tokyo.ac.jp