Civil Engineering Research Laboratory

Brief Overview

The Civil Engineering Laboratory extensively promotes studies like geology and geotechnical engineering, earthquake engineering, structural engineering and fluid dynamics which are essential for maintenance works and natural disaster reduction on electric power civil engineering facilities and back-end management in nuclear fuel recycle.

Achievements by Research Theme

Geosphere Science

【Objectives】

To solve issues associated with the siting and construction of electric power facilities; maintenance and asset management for aging facilities, we qualify the evaluation methods for earthquake faults, estimation methods for the explosive magnitude of volcanic eruptions, the assessment methods for the stability of underground facilities and the methodology for groundwater solute transport modeling.

【Principal Results】

- The capability of electrical resistivity was discussed, focusing on improved effect of unconsolidated ground with chemical grouting using cement. This method, which evaluates the improved effect and monitoring of filling situation of void, are valid in the ground surface composed of sand gravel and clay [N10033].
- The mass transport investigation method in unsaturated ground which is currently developed in the Civil Engineering Laboratory was employed to simulate migration phenomenon of leaked insulating oil in subsoil in a laboratory. As a result, use of X-ray CT scanner visualization revealed that the insulating oil is likely to stay in the subsoil despite of rainfall infiltration [N10038].

Earthquake Engineering

【Objectives】

We construct the methodology for design ground motion estimation for electric power facilities. In addition, we develop structural health monitoring (SHM) techniques and seismic control design method to establish effective maintenance works on earthquake resistant capability of a large electric facility.

【Principal Results】

- We developed the source modeling method for large-scale earthquakes incorporated with complex fault geometries. Microtremor measurement is carried out in the heavily damaged region during the 1891 Nobi earthquake, then a planar seismic responses analysis showed the location of buried fault line.
- Ambient vibration-based damage detection is experimentally examined in a full-scaled high-rise steel building test on the world largest E-defense shake table. As a result, system identification technique, developed in Civil Engineering Laboratory, clearly detected severe damage like rupture in several structural elements.

Structural Engineering

【Objectives】

To secure safety and reliability of steel and concrete structures and to extend the lifespan of those structures, we develop structural performance evaluation methods considering natural hazard actions such as earthquake, wind, heavy snow and others, and aged deterioration caused by environmental actions.

【Principal Results】

- We developed a soundness evaluation method for underground reinforced concrete structures at nuclear power stations under seismic action. The method includes several evaluation items for damage estimation with emphasis on maximum response during an earthquake, durability, structural performance and repair effect after earthquake. (This is part of a cooperative contract study of Japanese electric power companies.)
- The criteria in stress assessment of existing dam spillway gates were investigated from the reliability analysis of 57 in-service gates incorporated with the uncertainties in a design-based calculation, a finite element analysis and a field measurement of structural members. As a result, use of a sophisticated finite element stress analysis or a stress measurement under given load enabled to establish criteria beyond a design allowable stress value [N12].

Fluid Dynamics

【Objectives】

We conduct fundamental research related to fluid dynamics in order to establish mitigation measures for electric power facilities against natural disasters such as heavy rain, heavy snow, strong winds and tsunami, and also to improve solar, wind, and hydraulic power generation/operation technologies.

【Principal Results】

- We have developed a survey method of tsunami inundation area based on a chemical analysis of soil, and verified it to a field survey on the 2010 Chilean tsunami. As a result, bromide, chlorite and sodium ions are very effective to accurately distinguish inundated soil from non-inundated soil, which may provide objective and qualitative data about tsunami inundation area [V10008].
- We have examined the favorable numerical analysis conditions of the Numerical Weather Forecasting and Analysis System (NuWFAS) developed by CRIEPI, for next-day forecast of solar radiation, which will be needed for efficient use of photovoltaics (PV) systems in future. Use of tactical conditions for cloud physics, solar radiation model, and the number of grids for atmospheric layers (Fig. 1) well improved the forecast accuracies [N10029].

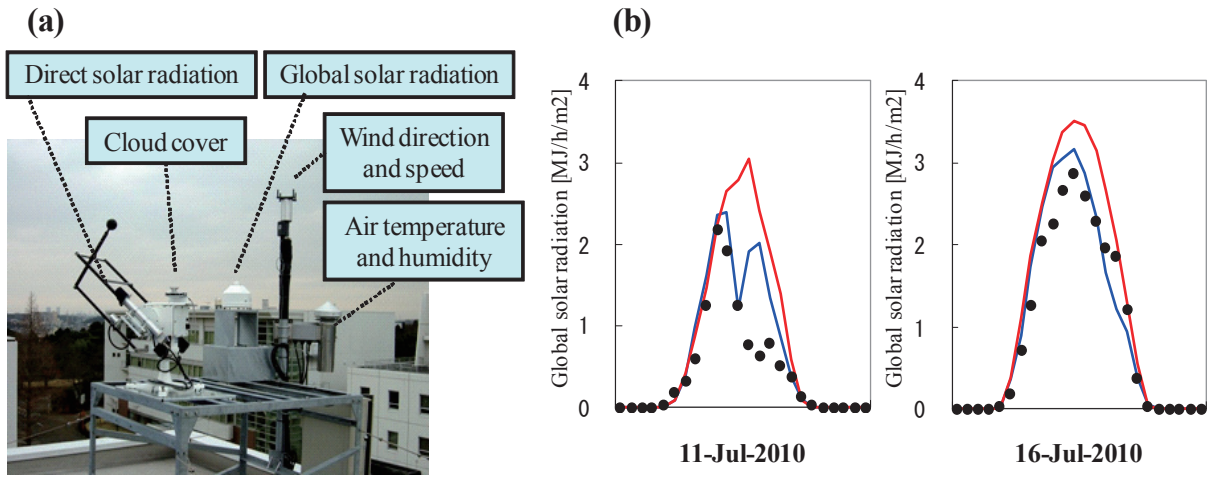

Fig. 1 (a) Field measurement system installed in Abiko, Japan to validate prediction accuracy of solar radiation model. (b) Numerical results for next-day forecast of global solar radiation by NuWFAS (red solid line: original model, blue solid line: improved model using the developed conditions) in comparison with field values measured at every one hour (black solid circles).