Civil Engineering Research Laboratory

Brief Overview

The Civil Engineering Research Laboratory is engaged in fundamental research themes related to geosphere science, earthquake engineering, structural engineering, and fluid dynamics. Research activities are required to create advances in civil engineering and disaster mitigation technologies for electric power facilities, and in technical support for nuclear fuel cycle backend projects.

Achievements by Research Theme

Geosphere Science

【Objectives】

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

【Principal Results】

・We propose an evaluation method of magma viscosity based on petrological analysis of erupted materials. The method is one of the constituent technologies that we use to assess the effect of large-scale eruptions on important facilities of utilities. It is feasible to apply the method to assess the likelihood of large-scale eruptions, which are low-frequency events [N09017]. We also clarify the characteristics of volcanic ash-fall as well as its effects on electricity facilities. We point out the necessity to communicate risks of volcanic ash-fall and to develop risk communication methods, based on the characterization and in terms of volcanology, disaster mitigation and sociology viewpoints [N09031].

・The thermal resistance of soil is important to determine the power transmission capacity of underground transmission lines. It was revealed that the thermal resistance can be estimated simply and with low-cost by combining the electrical survey and the S-wave seismic survey [N09019]. (This result was executed as a funded research from The Kansai Electric Power Company.)

Earthquake Engineering

【Objectives】

Evaluation method of ground motion for seismic safety of electric power facilities is improved and the basis of natural disaster risk assessment for business continuity plan is established.

【Principal Results】

・Source characteristics of the 2009 Suruga-Bay earthquake was revealed using the inversion technique with strong-motion records observed on the rock outcrops near the source area [N09008]. Obtained results were applied to the reevaluation of the design basis ground motions on the Hamaoka Nuclear Power Plant. In addition, our proposing method [N08] to estimate the damping factor of rock using its standard deviation of random velocity fluctuation is applied to subsurface structure modeling for seismic safety evaluation of nuclear power stations in the Wakasa Bay region.

・Business operation and recovery model during the earthquake disaster is developed based on the survey of industries following the 2004 Central Niigata Earthquake.

Structural Engineering

【Objectives】

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

【Principal Results】

・To develop a damage evaluation method for underground reinforced concrete structures at nuclear power stations that suffer from seismic action, loading tests of the models of reinforced concrete members were conducted. Based on the test results, we recommended criterion for shear failure of members with deformation-based indexes and also showed applicability of non-destructive tests for estimating maximum deformation level within experience deformation levels. (This is part of a common study of Japanese electric power companies.)

・Uncertainty in stress assessment of radial gates was evaluated from a comparison of analysis based stress obtained from theoretical formulas generally used in the gate design and 3D finite element method with the actual stress measured on forty existing spillway radial gates. Adjusting way of allowable stress value was proposed according to the difference in uncertainties between stress calculation methods.

Fluid Dynamics

【Objectives】

To preserve electric power facilities from damage caused by natural disasters such as heavy rain, storm surge, strong winds, heavy snow, tsunami, and volcanic eruptions, we predict those natural phenomena with meteorological models and fluid dynamics analyses. We also develop fluid dynamics analysis technologies related to the operation of hydroelectric power stations and wind farm.

【Principal Results】

・To evaluate the effect of tsunami on nuclear and thermal power plants, we developed a numerical analysis system which allows us to simulate not only propagation of tsunami from its origin to harbors, but also seabed erosion and sand deposition. It is shown that the system enables us to estimate topography changes due to three-dimensional flow in a harbor with good accuracy (Fig. 1) [N09004].

・To clarify the effects of driftwood, which flow into dam reservoirs after heavy rain, on the blockage of spillways and discharge through spillway, we proposed an experimental formula to predict whether or not driftwood blocked up spillways. It is also shown that we can use the formula to conservatively estimate the maximum water level in dam reservoirs under blockage of spillways [N09012].

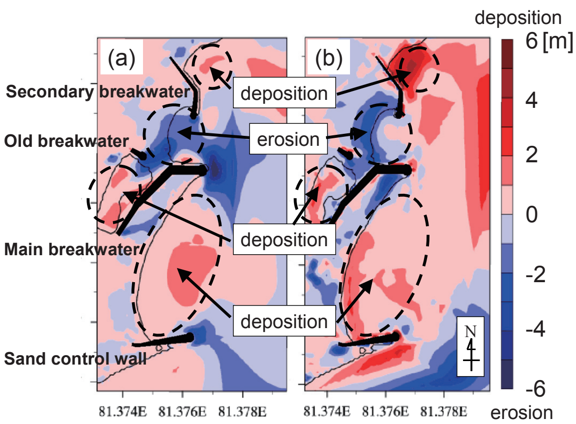

Fig. 1 Topography change induced by the 2004 Indian Ocean Tsunami (Sri Lanka, Kirinda port)

(a) Topography changes estimated through numerical simulation, (b) Topography changes estimated by on-site surveys before and after the tsunami (provided by JICA). These figures show that the numerical analysis system is able to simulate erosion (blue) and deposition (red) areas near the harbor.