Civil Engineering Research Laboratory

Brief Overview

The Civil Engineering Research Laboratory (CERL) is engaged in research featuring the siting and construction, natural hazard reduction and maintenance of electric power facilities and other infrastructure facilities. The scope of the R & D activities of the CERL also covers various aspects of the back-end nuclear fuel cycle, such as the transportation and storage of spent fuel, disposal of radioactive waste and recycling of demolition waste.

Achievements by Research Theme

Computational Fluid Dynamics (CFD) Technology

[Objectives]

To develop cutting-edge CFD methods into practical tools and to improve the prediction accuracy of the weather, tsunami and other phenomena.

[Principal Results]

- A new software was developed to analyse flow phenomena accompanied by electromagnetic or magnetic force and the vibration reduction effect of a passive MR (magneto-rheological) damper was verified. [N08026]
- New methods were developed to analyse compound coupling issues where fluid interacts with structure, air, water, sand and/or other. One of the methods was applied to the analysis of the sloshing of a petrol storage tank with a floating roof. [N08025]
- New methods for estimation the inundation tsunami force and amount of sand transport by tsunami were developed to assess the impacts of tsunami on port facilities. [N08004; V08064; N08085]
- A new method was developed to accurately predict heavy rain, flooding, strong wind, high ocean waves and seasalt damage by a typhoon or low pressure system, contributing to the reduction of the damage caused by meteorological disasters to power facilities. [N08014; N08017 and Fig. 1; N08020; N08021; N08058]

Structural Performance Assessment Technology

[Objectives]

To advance non-linear structural analysis, the earthquake-resistance test technology for structures, and the structural performance assessment technology.

[Principal Results]

- An evaluation method of the structural soundness of aged RC underground structures, which were used for water intake/discharge systems at nuclear stations, was established by means of clarifying the effects of concrete deterioration associated with aging on the structural performance of these structures during their service period. [N08083]
- An analysis code was newly developed to evaluate the cumulative fatigue damage of steel structural members of overhead transmission towers under buffeting, ands a wind resistance reliability design method of overhead transmission towers was established, based on design wind speed considering the wind direction effect at each construction site. [N08060; N08070]
- A simple eddy current test meter was newly developed to evaluate the quantity of corrosion products of twisted zinc-coated steel wires for power distribution lines, and a non-destructive test method was developed to estimate the thickness of the zinc coating and residual cross-sectional area of the steel wires. [N08078]

Seismic Risk Mitigation Technology

[Objectives]

To develop a strong motion evaluation, seismic risk assessment and seismic design technology for structural health against earthquakes.

[Principal Results]

- For the purpose of assessing the seismic hazard of important power facilities, an advanced method to predict seismic strong motion was developed, integrating assessment by a deterministic approach with a probabilistic approach. A proposal seismic design spectrum was also developed to predict long-period ground motion. [N04; N08007]
- Technologies to detect and identify damage to civil engineering power-related structures which are in operation and being reinforced were developed and upgraded and their applicability to real structures was verified. [N05; N08042]
- Through conducting shaking table tests as well as centrifuge test, the ground settlement mechanism of the backfilled ground around

the nuclear power plant buildings during the 2007 Niigataken Chuetsu-oki earthquake was analysed and a simple method to estimate such a ground settlement was developed. [N08005; N08029]

Geosphere Environment Behaviour Prediction Technology

[Objectives]

To upgrade the ground property assessment method, groundwater behaviour prediction method and method to assess the impacts of volcanic activities.

[Principal Results]

- The prospect estimation of hydraulic conductivity was created by using geophysical exploration methods through laboratory and in-situ measurements of relationship between streaming potential generated by elastic wave (Electro-Kinetic potential) and hydraulic conductivity. [N08080]
- The influence of the wet environment on the instability of tunnels in sedimentary rock under seafloor was investigated and a method to evaluate the tunnel stability including such impact was developed. [N09030] In addition, through detailed analysis of dissolved organic matters, utilizations of humic substances are demonstrated to be useful in establishing a groundwater flow model in a wider area. [N08016]
- Multidisciplinary issues in reducing large risks caused by less frequent hazards were pointed out through the studies of a hazard map of the eruption history at Esan volcano and of classification of human errors responding to natural disasters. [N08053 and Fig. 2; N05024]

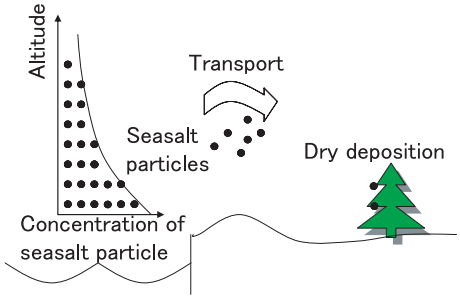

Fig.1 Conceptual diagram of the numerical code, NuWiCC-ST, for evaluation of seasalt transport

The numerical code 'NuWiCC-ST' enables us to estimate the amount of airborne seasalt particles over complex terrains. The amount of seasalt particles over the sea upwind a terrain is presumed by using statistics of wind observations. The method is used to take preventive measures against seasalt damage in electric transmission line and substation.

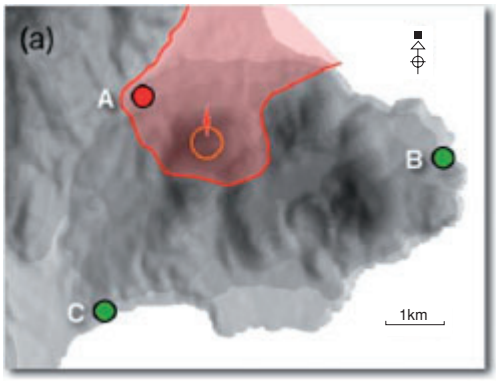

Fig.2 An example of hazard map at Esan volcano by its long-term eruptive history.

Hazard assessment of the effect of long-term variation in volcanic activity is demonstrated. The variation of eruptive points (orange circles) clearly results in different areas likely to be affected by pyroclastic density current (red blankets). A, B, and C are the assumed location of facilities.

Red circle: affected; green circle: unaffected. Arrow: major flow direction of pyroclastic density current.