Civil Engineering Research Laboratory

Brief Overview

The Civil Engineering Research Laboratory is engaged in research regarding with siting and construction of electric power civil engineering structures and other social infrastructures, reduction of the effects of natural hazards on these structures and the maintenance work for existing structures. The scope of the R & D activities of the Laboratory also include nuclear fuel cycle management, such as the transportation and storage of spent fuel and the disposal of low as well as high level radioactive waste.

Achievements by Research Theme

Computational Fluid Dynamics (CFD) technology

[Objectives]

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

[Principal Results]

- The applicability of the codes to analyze sand transport and topography changes caused by tsunami was evaluated based on the existing test data. In addition, an ocean wave model taking the state of waves and the effects of wave splash into consideration was developed.
- A computational model for the seismically induced-sloshing of an liquid storage tank with a floating roof was developed and the effectiveness of this model was evaluated based on shaking table test results.
- Using the meteorological observation data, the weather prediction model, the wind field prediction model and the water cycle model were improved and the applicability of the improved models was confirmed.

Structural performance assessment technology

[Objectives]

To enhance nonlinear structural analysis and hybrid seismic test technology for structures and structural performance assessment technology, etc.

[Principal Results]

- Analysis codes SLOSH-2D and SLOSH-3D were developed to simulate overflow behaviour of spent fuel pools associated with sloshing induced by long-period ground motion. The applicability of these codes was verified and observed overflow events during the past earthquake were evaluated.
- A new numerical code was developed to evaluate the wind resistant reliability. This code enables us to investigate (i) the safety evaluation of overhead transmission towers based on the current design methods and (ii) reliability analysis which takes the wind direction effect into consideration.
- Current structural assessment technology on concrete structures was effectively dedicated to establish Recommendations for Evaluation of Structural Soundness of Crucial Civil Engineering Structures at Nuclear Power Stations (published by the Japan Society of Civil Engineers in July, 2008). The recommendations provide the evaluation of structural performance assessment taking concrete deterioration associated with aging into consideration.

Seismic risk mitigation technology

[Objectives]

To develop strong ground motion prediction and seismic risk assessment technology and structural health monitoring technology

[Principal Results]

- The source process was investigated by inversion analysing technique using observation records for the main shock of the 2007 Niigata-ken-Chuetsu-Oki Earthquake and a source model needed for the evaluation of strong ground motion was developed.
- 1G shaking table tests were conducted and centrifuge model test to analyze the ground settlement mechanism of the backfilled ground around the main buildings in the Kashiwazaki-Kariwa Nuclear Power Station during a strong ground motion caused by the 2007 Niigata-ken-Chuetsu-Oki Earthquake.
- A new technique to identify the rapidly changing pattern of natural frequency of a structure during an earthquake motion was developed to enhance the technology to detect damage to large structures. The feasibility of this technique was confirmed through its application to earthquake records for seismic isolated structures.

Geosphere environment behaviour prediction technology

[Objectives]

To enhance the ground property assessment and groundwater behaviour prediction method as well as the method to assess the impacts of volcanic activities

[Principal Results]

- Effective data was obtained by applying a long-term measuring system using the wireless sensor network (WSN) to monitor the behaviour of natural slope failure.
- Dynamic characteristics of discontinuous rock mass, which had never been measured by in situ tests, was obtained by applying the in situ triaxial rock mass test system developed by CRIEPI to discontinuous rock mass having cracks.
- Based on the field test results for an actual coal-mine tunnel below the seabed, the temporal-spatial region subject to hydraulic impacts followed by the excavation of the tunnel was identified. In addition, the actual reflooding speed after tunnel closure was measured to assess the permeability of the entire tunnel.

Maintenance technology for hydropower civil engineering facilities

[Objectives]

To investigate methods to assess and analyze the impacts of large-scale natural disasters on hydropower civil engineering facilities

[Principal Results]

- Using the actual damage records concerning heavy rainfalls and facility accidents which are the most frequent disasters, disaster scenarios of hydropower plants were developed to show how the occurrence of a disaster will lead to adverse impacts on society. Focusing on some of typical scenarios, methodologies were developed to estimate disaster occurrence probability and social losses including the loss of an electric power company.
- To evaluate the earthquake resistant performance of dam spillway facilities during a significant ground motion, a structural test on dam gate models was conducted to characterize the load carrying capacity.
- As in situ trench survey was conducted in connection with a cave-in phenomenon above head race tunnels, the piping phenomenon was confirmed to be the main cause.

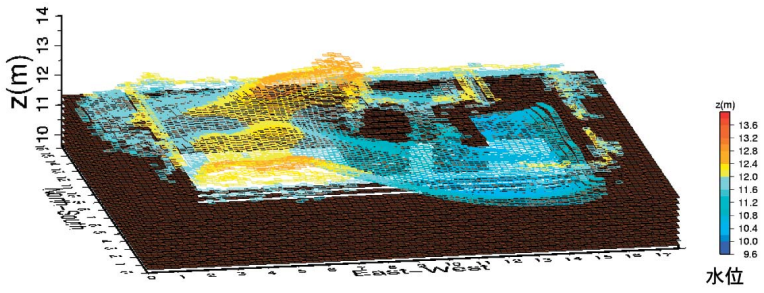

Fig.1 Numerical Evaluation on Spent Fuel Pool Overflow

Fig.2 In Situ Triaxial Rock Mass Test System Developed by the Laboratory