Disaster Prevention and Maintenance for Hydropower Facilities

Background and Objective

Proper maintenance, renewal and operation of hydropower facilities are important in terms of provision for global warming and stable electric power supply while the number of them constructed more than 50-60 years ago is increasing. In recent years, deterioration of the facilities and changes which appear in environments surrounding rivers and forests along ones are remarkable, and the increase of the number and scale of disaster affects hydropower operations.

In this project, evaluation and analysis methods for existing dam structures will be established to secure safety against strong earthquakes considering ultimate and limit states of the structures. Also, techniques which estimate points/places of sediment yield in dam basin and observe behavior of sedimentation and turbidity in rivers and reservoirs, and the simple analysis model which predicts sediment level and turbidity will be developed.

Main results

1. Seismic performance evaluation for aged dam structures

Static and monotonic loading tests of concrete gravity dam models (Fig. 1) were conducted focusing on the fracture behavior at contact zone between dam and foundation. The test parameter was contact condition between dam and foundation, and the loading condition was equivalent to the dam's self-weight, water pressure and seismic load. As the result, the stress and strain condition and the fracture behavior near the contact zone were demonstrated.

Static and cyclic loading tests of spillway gate models (Fig. 2) were conducted focusing on the buckling of primary members. The test parameter was truss shape between the strut arms. The models were subjected to hydrostatic and earthquake loads to investigate buckling modes, deformed positions and maximum strength. The results will be utilized for evaluating the behavior of gates where primary members were buckled by using a simple seismic response analysis.

2. Development of observation technique and prediction model for sediments

New "Watershed Environment Database" was established for the analysis of sediment discharge from forest roads and collapsed slopes. The database includes not only topographical and geological data above dam basins, but also the information of the degraded forest areas and the non-reforestation areas interpreted from satellite images, aerial photographs and field observations.

In order to develop an evaluation method for slope stability along reservoirs, a soil-moisture monitoring system which is composed of an electrical resistivity system and a soil-moisture sensor, was installed at the examination site at a hydropower station. This system was applied to visualize and analyze changes of soil-moisture distributions under the slope ground (Fig. 3).

Also, in order to investigate processes of sedimentation and turbidity in reservoirs, a movable current measuring system which equipped the Acoustic Doppler Current Profiler (ADCP) and the Global Positioning System (GPS) were installed, and cross-sectional profiles of velocity were measured in a reservoir (Fig. 4). In addition, two-dimensional numerical system was developed for estimating current and topography changes in rivers and reservoirs. These systems will be applied to field measurements for understanding processes of sedimentation and turbidity.

Other reports [N10], [N09018]

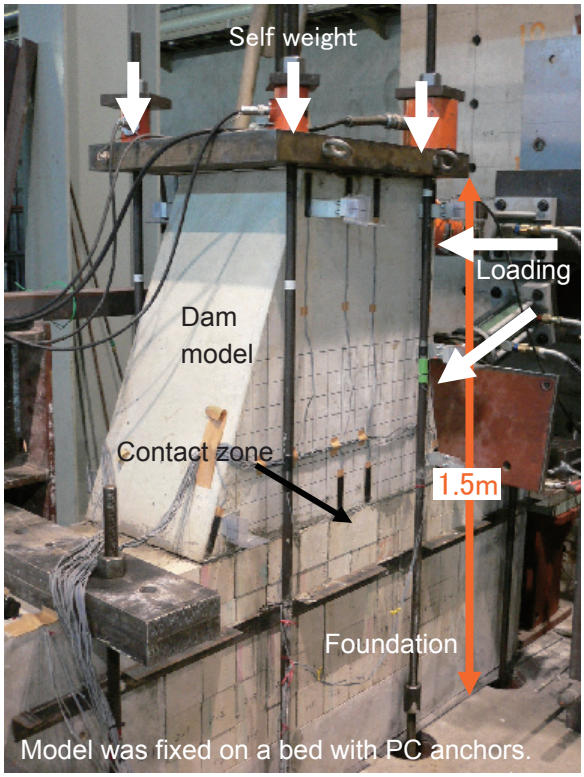

Fig. 1 Loading test of concrete gravity dam model
Test was assumed the dam's deformation of downstream direction under water pressure and seismic load.

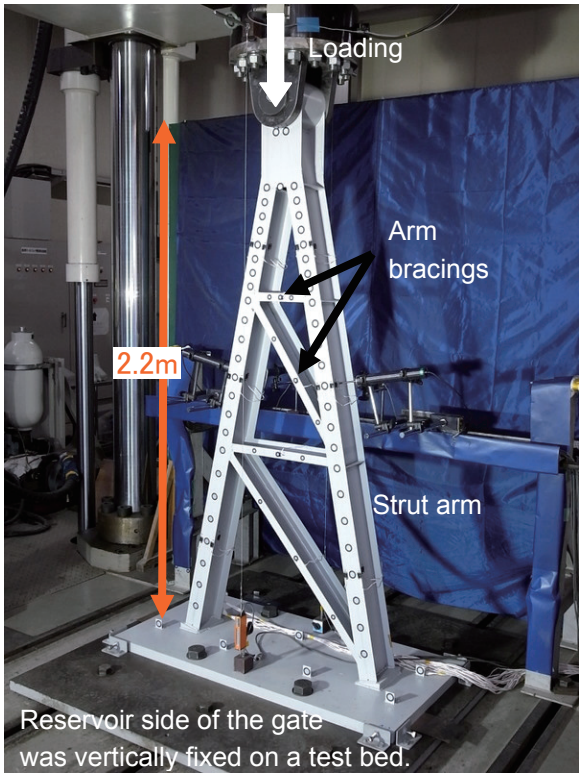

Fig. 2 Loading test of dam gate model
Test was assumed the axial buckling of strut arms under water pressure and seismic load.

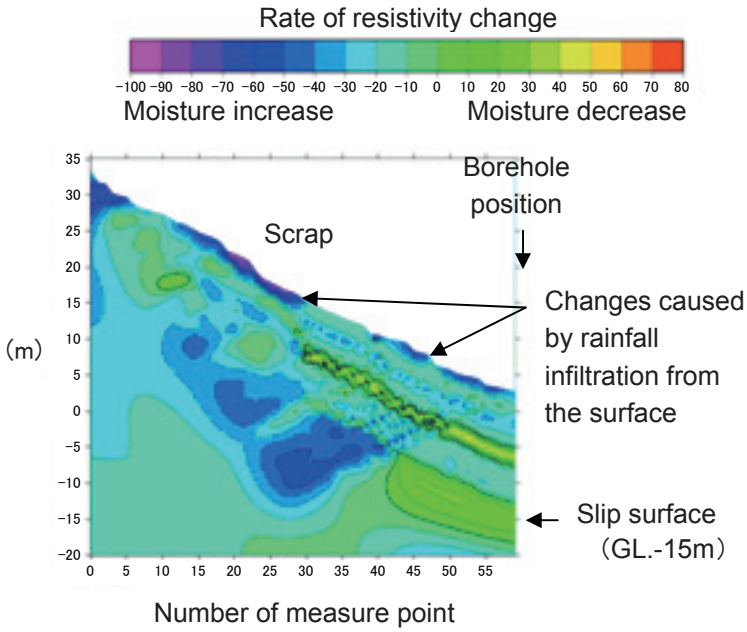

Fig. 3 Visualization example of soil-moisture distribution
Changes of soil-moisture distributions by the rainfall infiltration from surface and the groundwater flow from the upper slope were analyzed with an electrical resistivity system and a soil-moisture sensor.

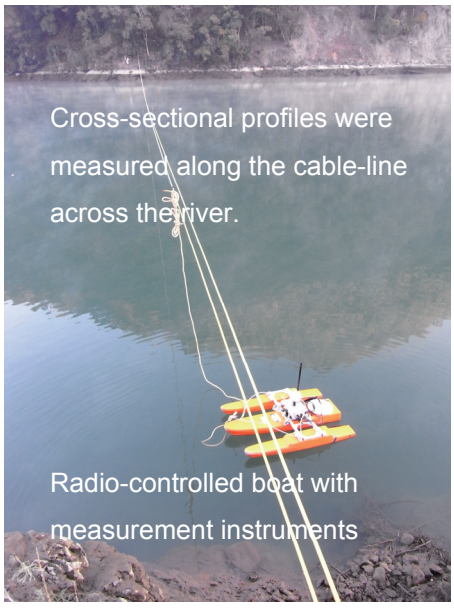

Fig. 4 Movable current measuring system
The ADCP and the GPS were placed on a boat, and profiles of velocity, turbidity and topography in reservoirs were measured.