Strategic Disaster Restoration Support Technology for Electric Power Distribution and Substation Equipment

Background and Objective

In order to effectively support the restoration activities for disaster damaged electric power distribution and substation equipment, their risk assessment and management technologies against disasters, which take into consideration the reliability and accuracy of obtained disaster information during the emergency restoration period, disaster force (hazard), and the diversity of the region and equipment, are needed.

The objective of this project is to develop a disaster restoration support system for equipment against mainly earthquakes and typhoons, which includes earthquake force and typhoon wind force evaluation systems, equipment damage assessment system, and emergency restoration process simulator in order to put it into practical use in an actual target electric power supply area.

Main results

1. Application of remote sensing technology to disaster restoration support for electric power distribution equipment

The reasonable combinations of a sensor and its movable body (platform), which enables us to realize high damage detection accuracy within 48 hours, were investigated. As a result, it was clarified that synchronizing the seismic damage estimation system (RAMP-Er) with laser scanner + aircraft (Airborne Laser), and Synthetic Aperture Rader + satellite (SAR satellite) has high potential to effectively support the emergency restoration work for electric power distribution equipment [N10023] (Fig. 1).

2. Development of a seismic damage estimation method for service lines

A seismic damage estimation method for service lines, which are severely affected by the damage of surrounding facilities, was developed. The proposed method enables us to estimate their seismic damage based on a performance index focusing on the tension of service line during an earthquake. The proposed method is applied to actual service lines damaged by the 2007 Niigata-Ken Chuetsu-Oki earthquake. As a result, it was clarified that the proposed index is more appropriate than seismic intensity for the damage estimation of service lines (Fig. 2)

3. Development of a tsunami information system

A basic evaluation module of a tsunami information system was developed. On the basis of the latest earthquake and tsunami information including earthquake parameters, the water levels of observed points, and detailed geographical features on surrounding coast, the developed module tries to estimate the water level fluctuation and inundation area caused by tsunami (Fig. 3).

4. Development of a an earthquake-resistance evaluation tool for electric power substation equipment

An experimental version of earthquake-resistance evaluation tool for electric power substation equipment (ELECTREE) was developed (Fig. 4). The developed tool consists of four functions: input earthquake ground motion generation, site response analysis, soil-pile interaction analysis and FEM analysis for substation equipment. The developed tool enables practitioners to easily evaluate the earthquake resisting capacity of actual substation equipment.

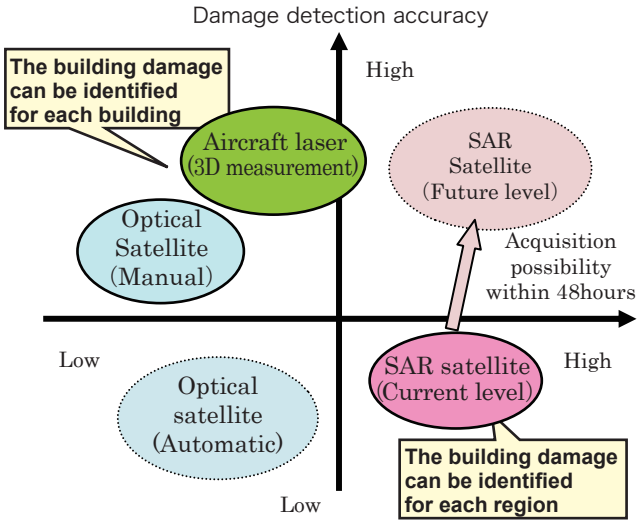

Fig.1 Damage detection accuracy of remote sensing technology and its image acquisition possibility within a target period (48 hours)

A reasonable combination of censer and platform, which we can get within 48 hours, is SAR and satellite. On the other hand, the combination that realizes higher damage detection accuracy is laser and aircraft with 3D measurement.

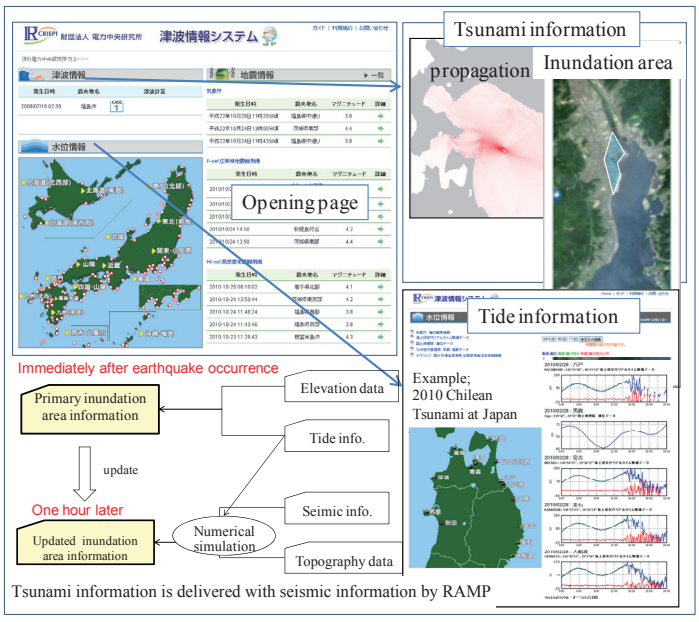

Fig. 3 Tsunami information system (TIS)

TIS enables power companies to provide latest inundation area information through RAMP since the earthquake occurrence.

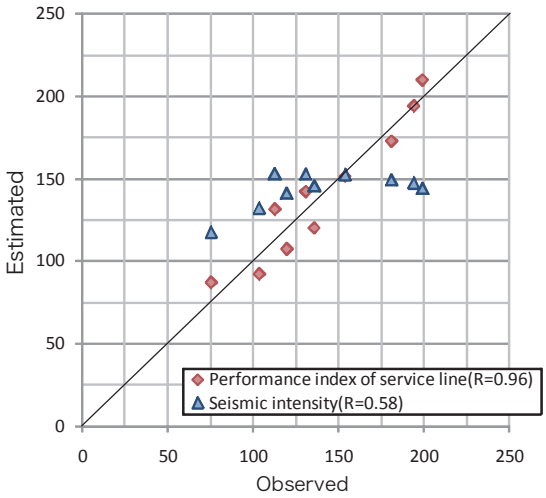

Fig. 2 Comparison between the observed and estimated numbers of the distribution poles with damaged service lines based on the seismic damage record caused by the 2007 Niigata-Ken Chuetsu-Oki earthquake

This indicates that the estimation accuracy based on the proposed index is higher than that on the seismic intensity.

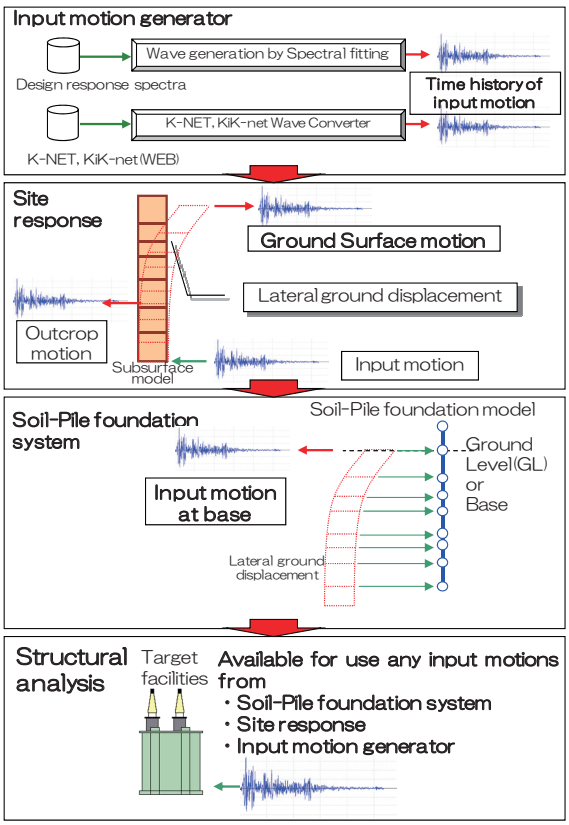

Fig. 4 Earthquake-resistance evaluation tool for electrical power substation equipment (ELECTREE)

ELECTREE enables us to evaluate the earthquake-resistance capacity for substation equipment considering input motion generation, site response, and soil-pile foundation type.