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研究成果報告書

研究課題名

大災害時ターミナル周辺地区および地下街の安全安心対策としてのオフサイトセンターの実証実験

Empirical study on off-site center as safety and security measures for buildings and underground malls around the major terminal station at the time of great natural disasters

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Abstract

Approximately five million people in the Tokyo metropolitan area were stranded during the Great East Japan earthquake. Measures taken to assist these stranded people became a significant social issue, along with measures to prevent such a crisis during future earthquakes that are expected to erupt directly beneath Tokyo and Nankai Trough and measures for aiding stranded people assume a maximum three day "stay" following an "evacuation". As lifeline functions are disrupted, facility maintenance is essential for securing residential environment, energy, and water necessary for an unspecified number of people seeking shelter. Therefore, a “mutual assistance scheme” is needed to provide a framework for members within each area to help others. Centralized control is necessary for managing this type of mutual assistance scheme.

This study, therefore, proposes an off-site center as a central control and considers the basic plans of the two main systems. The first is an emergency "BCD power supply system,” which would be shared by each shelter, while the second is a "BCD information system" to handle information management including collecting information from shelters within the district and delivering this information to stranded people. This study focused on an underground mall adjacent to the terminal train station, which played a significant humanitarian role in the Great East Japan earthquake by providing shelter to stranded people.

A basic study was conducted across 41 underground malls in Japan. The results revealed challenges related to the lack of a management system for stranded people, such as insufficient facilities (e.g., emergency power generation) for a long-term stay by stranded people.

The next survey addressed the indoor environment in underground malls during a period without air conditioning. A key issue in the development of an emergency power supply is energy needed for air conditioning. While this was not previously considered a need during disasters, a lack of heating and cooling in an indoor environment may affect the health of refugees and can even be life-threatening over a long-term stay. Therefore, with cooperation from two underground malls, the authors measured the indoor environment during a non-air conditioned period and conducted a sleep study on test subjects to evaluate sleep quality and fatigue among stranded people staying at a shelter. Experiments with test subjects were conducted during a summer, winter, and season between them. The experimental results confirmed that air conditioning is needed in both seasons, and heating is particularly needed during winter.

Next, BCD power supply system planning was also studied. First, energy demand was calculated for a case in which stranded people are taken into an underground mall during a disaster. Using BEMS data from an underground mall that actually provided shelter for stranded people during the Great East Japan earthquake, operating performance characteristics were analyzed for each facility to estimate the energy demand for summer, winter, and the intermediary period in order to secure the environmental targets obtained from the indoor environmental study of underground malls. This was followed by an analysis of urban space, which identified several local characteristics including

building use, districts surrounding terminal stations that should develop a BCD power supply system, level of accumulation of emergency power generation facilities, and whether a district heating system had been developed. Building upon these findings, a BCD power supply system plan, that coordinates with district heating systems using the district surrounding the Tokyo station as a model was developed. A detailed system simulation analysis confirmed that energy was conserved by 37% during normal times while power supply coverage improved by 1.95 times during a disaster.

Finally, a study was conducted to evaluate planning for BCD information systems. The main functions of a BCD information system include a smartphone environmental monitoring function to collect data on indoor environments being used as shelter areas, a facility monitoring function in which a facility manager uses mobile devices (tablets) to collect and submit information related to facility damage such as fires, and a mirroring function to display digital signage from shelters on the smartphone screens of occupants. This study built prototypes of the aforementioned equipment and conducted experiments using an underground mall and the university campus as the field. In particular, the study was able to verify the development potential of a disaster-time network unique to the district and independent from external networks.