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FUTURE PERSPECTIVE OF CONTRIBUTION TO RESEARCH ON EARTHQUAKE-DISASTER RISK REDUCTION WITH E-DEFENSE

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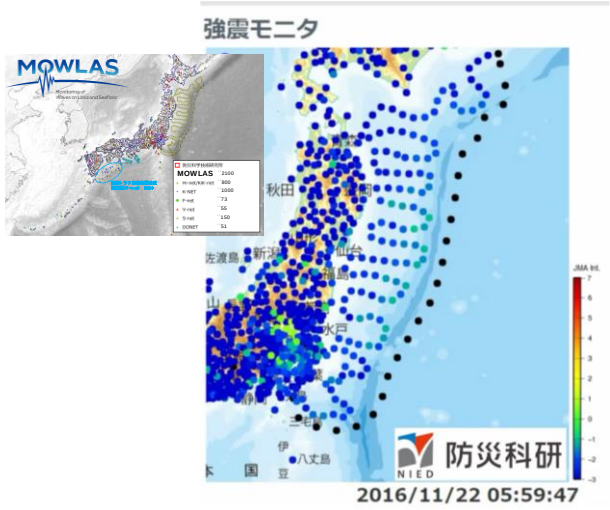
NIED overview

NIED is a national agency of MEXT, established in 1963 to promote R&D in DRR.

NIED covers all aspects of prediction, prevention, response, and recovery related to **disasters caused by natural hazards** such as earthquakes, tsunamis, volcanoes and extreme weather.

NIED operates unique observation networks and test facilities: **E-Defense is for large scale shaking tests**.



MOWLAS Observation NW

Large-Scale Rainfall Sim.

Cryospheric Env. Sim.

E-Defense

Director Yoshiaki Nakano, Professor, IIS, Tokyo Univ

E-Defense overview

E-Defense is the shake table test facility for observing the **failure process** of a maximum 1,200-ton **full-scale structure**.

Its **300m^2 3-D shake table** can **accurately simulate the ground motions** recorded in the 1995 Kobe and 2011 eastern Japan eqs.

127 experiments have been completed since its operation started in 2005.

NIED operates it as a **communal-use** facility and provides the **datasets online**.

E-Defense simulates the damage of full-scale structures.

NIED provides the datasets and knowledge on DRR.

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E-Defense experimental research themes to date

E-Defense adequately **simulates the behavior** of full-scale models during a large earthquake and **provides reliable datasets**, resulting in unique outcomes: 84 datasets are accessible online.

Clarification of collapse mechanisms

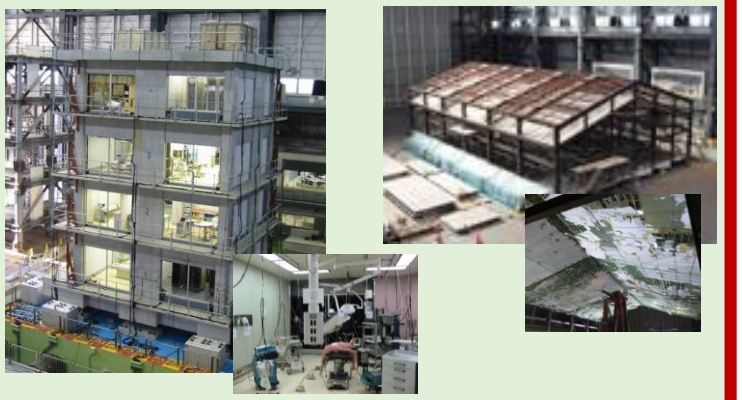
- Reproducing failure processes especially for structures build by old codes to obtain detailed data
- Assessing critical conditions of structures build by current codes to verify their effectiveness

Evaluation of current or new technologies

- Observing failure process to verify their seismic performance
- Identifying problems to improve design and/or develop countermeasures

Assessment of damage to functionality

- Understanding damage to non-structural components, rooms, equipment, etc. that affect the functionality of a building
- Proposing effective measures to control damage and continue activity



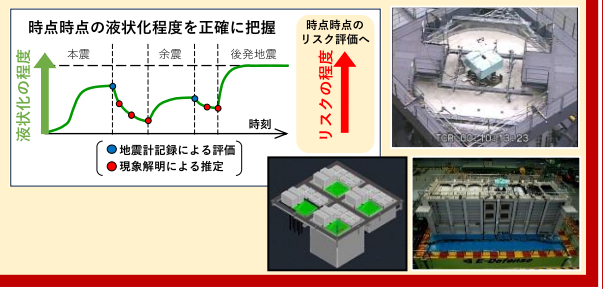
Ongoing research project with E-Defense

NIED researchers are working with E-Defense on 4 themes of subprojects focused on **estimating damage conditions and predicting risks in regional areas** to ensure the **continuity of social and economic activities**.

Assessment of damage to structures due to liquefaction

Kawamata, Aoki

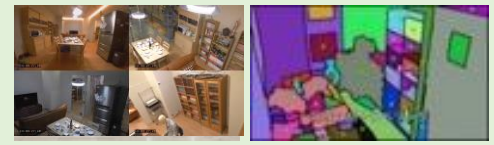
- Clarifying soil liquefaction process under partially drained conditions similar to the actual ground due to a series of large earthquakes.
- Establishing a database of various experimental and numerical studies.
- Developing damage assessment procedures based on the database.

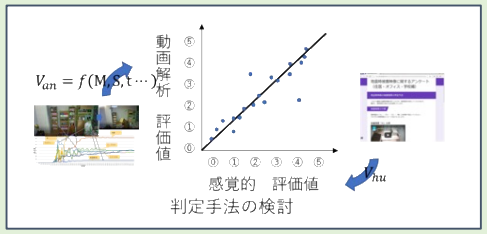


Development of multi-monitoring system for damage evaluation

Sato, Fukui, Komatsu, Abe

- Developing the sensing technology using image and acoustic data
- Establishing the damage-evaluation platform for structures and their inside, expanding regional damage

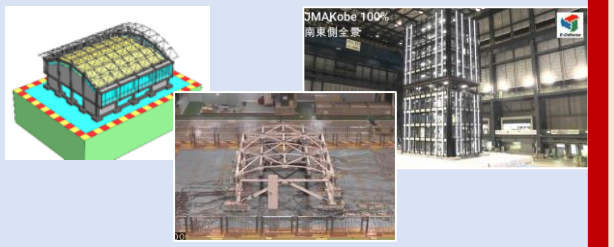




Evaluation of damage of buildings with large space

Fujiwara, Nishi, Kajiwara

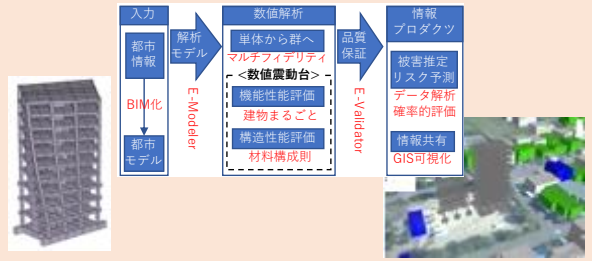
- Developing technologies for analyzing the time change in dynamic characteristics of a building in service and for evaluating the damage to the building after large earthquake based on the analysis, in order to assess its continuous use.
- Designing the test on a building with large spaces, following the 10-story steel frame building.



Establishment of simulation platform for regional areal damage assessment

Yamashita, Omura, Horiuchi

- Improving detailed FEM "E-Simulator" to precisely simulate an entire building with non-structural components.
- Developing the simulation platform consisting of urban information processing, multi-fidelity simulation framework, data analysis by machine learning, and GIS.



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For the reliable resilience against the next one…

Reliable resilience in regional areas against the future large earthquakes to ensure the continuity of social and economic activities is a ***common goal in countries*** where earthquakes occur frequently.

Earthquake engineering can contribute to making resilience more reliable by **developing technologies for mitigating damage to various structures**, as well as **for damage evaluation and risk assessment applicable at various scales**.

To satisfy the resilience reliable, these technologies should be ***evidence-based***, i.e., they **need to be V&V-based on data and findings** from observations of actual phenomena and experiments in their research.

Good datasets for evidence-based tech V&V are needed.

Large-scale experiments can provide high quality datasets as evidence because they have good advantages in reducing scale effects and in acquiring detailed data from a large number of sensors, which can be used as V&V ***reference data valuable to all*** researchers and engineers.

E-Defense, in particular, is a unique test facility that can obtain the **good datasets of cases of artificial disasters** from experiments on full-scale specimens of structures.

NIED expects that the E-Defense datasets to be used not only in the (original) research projects of the experiments, but also in other studies.

For dataset distribution…

While E-Defense datasets are currently provided “as is” mainly in Japanese, **additional materials and services essential** for developing a common understanding of the experiment.

Online datasets dstb’n through ASEBI
doi.org/10.17598/nied.0020

Functions considered to be developed and/or improved to promote and facilitate the use of the dataset:

Help users find experiments of interest and allow users to find new interest in experiments.

- Develop and publish a "data paper" with a summary of each experiment
- Improve reference and search efficiency by assigning a DOI to each dataset
- Unify the structures of each dataset by establishing "metadata"
- Develop AI-based search tools that can extend the coverage of datasets

Allow users to download the data they want from the datasets.

- Renovate the online system compatible with English
- Assign a DOI to each dataset
- Develop metadata
- Enhance and improve the quality of the datasets by including various materials such as design documents, reports, papers, additional test data, etc.
- Establish the maintenance system to continuously provide and appropriately improve the online system (technicians, budget, etc.)

For experiment co-creation…

To continue to obtain valuable data from future E-Defense experiments, it is effective to **co-create *global ideas*** through discussions with many researchers and engineers, as well as through their research activities using E-Defense data, and to **plan and promote the implementation of experiments based on the global ideas**.

Discussions for MOC renewal with NHERI members, US

MOC with SESTEC, Pusan U., Korea

Hualien eq. reconnaissance, collab. tests and mtg's with NCREE, Taiwan

Discussions with Professor Lignos, EPFL, Switzerland

For good collaboration…

Collaboration with the same research goals at large-scale test facilities can maximize the development of data, as well as researh results and knowledge: Global ideas can foster collaborative experimental research activities.

In such collaboration, **since many researchers and engineers participate, materials are essential for developing a common understanding** of the experiments, and the data obtained can be shared with many more researchers and engineers.

To facilitate the above efforts, it will be essential and effective to establish a framework of ***research infrastructure network***, including large-scale testing.

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