NIED E-Defense Facility
and its Future Use

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Hanshin- Awaji Earthquake Disaster

Mid-Story Failure of Reinforced Concrete Buildings
Brittle Failure of Steel Structures
Collapse of Highway and Railway Bridges
Failure of Soil-Pile Foundation-Structure by Liquefaction
Collapse of wooden structures
Objectives of E-Defense

3-D Motion

Failure Test

Full-Scale Model

Bird Eye View of E-Defense

Outside Equipment Area

Exterior Building

Preparation Building

Hydraulic Unit Building

Experiment Building

Shaking Table

Operation Building
Shaking table and actuator system

Specifications of Shaking System

<table>
<thead>
<tr>
<th>3-D Full-Scale Earthquake Testing Facility</th>
<th>Payload Size</th>
<th>Driving Type</th>
<th>Shaking Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>12M N (1200tonf)</td>
<td>20m × 15m</td>
<td>Accumulator Charge</td>
<td>X - Horizontal</td>
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<td></td>
<td></td>
<td>Electro-Hydraulic Servo Control</td>
<td>Y - Vertical</td>
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<table>
<thead>
<tr>
<th>Maximum Acceleration (at Maximum Loading)</th>
<th>&gt;900cm/s²</th>
<th>&gt;1,500cm/s²</th>
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<tbody>
<tr>
<td>Maximum Velocity</td>
<td>200cm/s</td>
<td>70cm/s</td>
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<tr>
<td>Maximum Displacement</td>
<td>±100cm</td>
<td>±50cm</td>
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<tr>
<td>Maximum Allowable Moment</td>
<td>150M N m</td>
<td>40M N m</td>
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</table>

Turning Moment: Overturning Moment = 150M N m

Yawing Moment: 40M N m
Recent Condition in Experiment Building (December, 2003)

Special Project for Mitigation of Earthquake Disaster in Urban Areas (Dai-Dai-Toku) by MEXT (FY2002～2005)

- No.1 Quake-Motion Estimation
  - Investigation of Tectonic Structure
  - Quake Motion Estimation Map

- No.2 Quake Resistance
  - Experiment and Simulation of Structure Collapse

- No.3 Optimization of Disaster Response
  - Rescue Robot
  - Simulation of Disasters

- No.4 Guideline for Countermeasures to Mitigate Earthquake Disaster
  - Integration of Disaster Prevention

Mitigation of Earthquake Disaster
Significant Improvement of Seismic Performance of Structures

【Technical Data】
- Preparation of E-Defense
  - Simulation of shaking table
  - Database for Earthquake motion
  - Preliminary Fracture Experiment (RC, Foundation, WH)
  - Numerical simulation of Fracture for structures

【Operation】
- Full size Fracture Experiment by E-Defense
- Improvement of Durability of Structures for Earthquake

Operating Organization of E-Defense

Schedule of Experimental Research by E-Defense
(RC, Soil-Foundation, Wooden House)

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<th>2002</th>
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<td>Construction of E-Defense</td>
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<td>2005</td>
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<td>Opening</td>
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<td>Existing shake table</td>
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<tr>
<td>New projects (Domestic, Oversea)</td>
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Experimental research using E-Defense

Opening
General plan of the full-scale RC structure test using E-Defense

- RC frame consists of 2 x 3 spans (@5m) and 6 floors
- The total height of the structure is 18 m.
- The mass of the model structure is about 800 ton.

Parameters of Experiment

【F.Y.2005】
- Comparison of the structures designed by guideline in 1970 and in 1997

【F.Y.2006】
- Effect of anti-earthquake reinforcement method

General illustration of the shake test plan in E-Defense

- Test on Soil-Pile-Structure Interaction
  - Large cylindrical laminar container
  - Height: 6.5m
  - Diameter: 8.0m

- Test on Lateral Spreading of Liquefied sand behind a Quay Wall
  - Huge soil container
  - Height: 4.5m
  - Width: 4.0m
  - Length: 18.0m
General illustration of the shake test plan in E-Defense

Existing House

Existing House with anti-earthquake reinforcement

Effects of anti-earthquake reinforcement method

Destruction test of old house reassembled on foundation above table

Development of numerical simulation for shake table

Contents of the Research
Development of pre-analysis method to simulate the table movement with high accuracy

Composition of simulation system
1) Table model
2) Mechanical system which is composed of servo-valves, actuators and 3-D link joints
3) Application and basic control system
4) Specimen model on the table.

Simulation model
Development of 3-D input motion database

**Purpose**
Provision of input earthquake motion for E-Defense.

**Ground motions stored in database**
1) Strong ground motion records in the world
2) Calculated waveforms

Calculated by 3-D strong ground motion prediction method

A prototype database (in Japanese)

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**E-D Net (E-Defense Network)**
Experimental & Numerical Simulation Data Exchange

Network for Asian-Pacific information organization

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Planning Meeting for NEES/E-Defense Collaboration
Held on April 6-8 in Kobe Japan