Research on Urban Earthquake Engineering at Tokyo Tech.  
- Earthquake Disaster Mitigation -

- The 2011 Tohoku Earthquake (M9)
- Anticipated Tokyo Earthquake
- Technologies for Earthquake Disaster Mitigation

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Japan is one of the most earthquake-prone countries.

Epicenters of Large Earthquakes
Damage Earthquakes with more than 1,000 Fatalities in Japan since Meiji era

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Magnitude</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1894</td>
<td>Nobi Earthquake M8.0</td>
<td></td>
<td>7,300</td>
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<tr>
<td>1896</td>
<td>Sanriku Tsunami M8.3</td>
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<td>22,000</td>
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<td>1923</td>
<td>Kanto Earthquake M7.9</td>
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<td>105,000</td>
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<td>1927</td>
<td>Kita-Tango Earthquake M7.3</td>
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<td>1933</td>
<td>Sanriku Tsunami M8.1</td>
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<td>1943</td>
<td>Tottori Earthquake M7.2</td>
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<td>1944</td>
<td>Tonankai Earthquake M7.9</td>
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<tr>
<td>1945</td>
<td>Mikawa Earthquake M6.8</td>
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<tr>
<td>1946</td>
<td>Nankai Earthquake M8.0</td>
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<td>1948</td>
<td>Fukui Earthquake M7.1</td>
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<td>3,800</td>
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<tr>
<td>1995</td>
<td>Kobe Earthquake M7.3</td>
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<td>6,300</td>
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<td>2011</td>
<td>Tohoku Earthquake M9.0</td>
<td></td>
<td>19,000</td>
</tr>
</tbody>
</table>

Strong Shaking during the 1995 Kobe Earthquake
Damage of the 1995 Kobe (Inland) Earthquake

The 2011 off the Pacific coast of Tohoku Earthquake
Magnitude: M_w 9.0
Number of dead and missing: 19,000
Number of displaced people: 300,000
Number of damaged houses: 1,000,000
Direct monetary loss: 200 billion US$
Tectonic Plates in the Japanese archipelago and surrounding areas

Fault Plane of the Tohoku Earthquake 500km Length

Pacific plate subducts Japan Islands, and Japan Islands spring up generating tsunami and shaking.

Video of Tsunami in Sendai

From You Tube
The area of intensity 5 upper (MMI 8) or greater is approx. 35,000 km².
Acceleration Time Histories of Strong Motion Records
During the 2011 event, duration of shaking is longer than 2 minutes.

Video of Earthquake Motion at Apartment House in Sendai (Intensity IX)

2011.3.11 東日本大震災 (M9.0)
仙台青葉区
camera: SONY DSC-WX5
From YouTube
Building Damage at Lowland of Sendai City

Video of Strong Shaking in Tokyo
Intensity 5 lower or 5 upper in JMA scale
Intensity VII to VIII in M.M. Scale
Long-period Ground Motion in Tokyo

approx. 150km far from the epicentral area

Displacement of 0.5 to 0.7 m was observed at the top of high-rise buildings. Many people felt fear, and operation of elevators was stopped.

Damage of Ceiling in Tokyo Area
Soil Liquefaction in Tokyo
A phenomenon whereby a saturated or partially saturated sand soil substantially loses strength and stiffness in response to earthquake shaking, causing it to behave like a liquid.

Anticipated Mega-quake along Nankai Trough (M9)

The Central Disaster Management Council of Japanese Government revised quake-tsunami estimates along Nankai trough. They estimate a tremendous earthquake striking in the 750-km Nankai Trough running from Honshu to Kyushu as the worst-case scenario.
Estimated Tsunami Height (Hmax >30 m)

Estimated Seismic Intensity (area of intensity IX or greater is 70,000 km²)

Anticipated Tokyo Earthquake (M7.3)

Building damage due to vibration

Building damage due to fire

Seismic intensity
Threat of Earthquake Disaster

↓

Necessity of Preparedness

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Development of Countermeasures with New technologies

Center for Urban Earthquake Engineering Center at Tokyo Tech.

City of high earthquake resilience

Three Major Research Areas

- Advanced Technology for Earthquake Disaster Mitigation
- Renovation Technology for Urban Earthquake Resilience
- Strategic Plan for Urban Seismic Risk Reduction

- Seismic Hazard & Risk Simulation Technology
- Earthquake Disaster Information System
- Intelligent Vibration Control of Buildings
- Seismic Retrofit Technology
- Seismic Evaluation of Lifeline
- Performance-based Design, Earthquake Education, Investment Strategy

About 50 faculty members in six departments in three Graduate Schools of Tokyo Tech are working for this program. Various research topics are conducted for earthquake disaster mitigation.
Advanced Seismic Hazard Simulation

By using our supercomputer TSUBAME, sophisticated earthquake ground motion simulation is conducted.

Ground Motion Simulation for Tokai Earthquake

Dynamic Tsunami Simulation

Tsunami Run-up Simulation
Automated Detection of Inundation Area from Satellite Images (FORMOSAT-2)

Before (2011/1/16)  After (2011/3/12)  After (2011/3/19)  Results

- Abukuma River
- Watari Town
- Pacific Ocean

Results:
- : Inundation on 3/12
- : Inundation on 3/19
- : Non Inundation
- : Border of Inundation by Visual Inspection of Aerial Photos

Base-Isolation Building at Suzukake-dai Campus

More than 100 sensors have been installed to monitor response during shaking due to quake and wind

Rubber Bearing to Absorb Seismic Energy
Damper System to Reduce Vibration of Wooden House

Evaluation of Indoor Safety during Earthquake by Shaking Table Test and Numerical Simulation
Simulation of Stranded People after Earthquake to Plan for Disaster

Our Goal is to construct Earthquake Resilient Society.

City of high earthquake resilience

Advanced Technology for Earthquake Disaster Mitigation

Renovation Technology for Urban Earthquake Resilience

Strategic Plan for Urban Seismic Risk Reduction

Seismic Hazard & Risk Simulation Technology
Earthquake Disaster Information System
Intelligent Passive and Active Control

Seismic Retrofit Technology
Seismic Evaluation of Lifeline

Performance-based Design, Earthquake Education, Investment Strategy

Urban Facilities
People
Urban System

Our symbol means to mitigate disaster by various measures.