Earthquake Resistance Standards of Buildings
(Focusing on Building Standards Law)

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Earthquake Resistance Standards are Specified by the Building Standards Law

Various standards are specified in the Building Standard Law, including earthquake resistance standards of buildings

1 Standards in urban areas
- (1) Relationship between building site and road
- (2) Purpose zoning
- (3) Building-to-land ratio
- (4) Floor area ratio
- (5) Building height

2 Standards for buildings
- (1) Fire prevention/evacuation
- (2) Safety in daily life
- (3) Living environment/Sanitation
- **(4) Structure (Earthquake resistance standards)**
- (5) Building equipment

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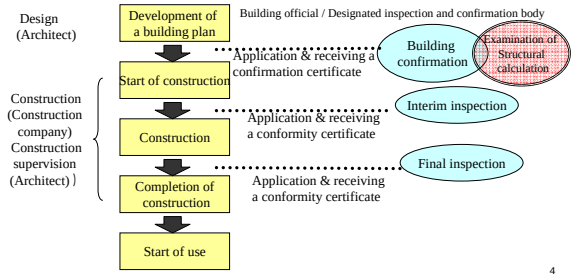
Procedures in the Building Standards Law

Procedures from the development of a building plan to the start of use are specified in the law and the involvement of the administration ensures the safety.



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Basic Concept of Earthquake Resistance Standards - 1

The basic concept is that the building structure must be safe against not only earthquakes but also the dead load, live load, snow load, and wind pressure.

Dead load:	Weight of concrete, reinforcing bars, etc.
Live load:	Weight of people, furniture, vehicles, etc.
Snow load:	Weight of snow
Wind pressure:	Swaying caused by wind
Earthquake:	Shaking caused by an earthquake

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Basic Concept of Earthquake Resistance Standards - 2

Deal with it based on the risk management concept and considering economic efficiency, rather than to build perfect buildings to resist any possible earthquake

(1) Regular dead load and live load shall be safely supported.
(2) No damage shall be caused by a medium earthquake that rarely occurs (once in 20 years).
(3) No fall or collapse shall be caused by a large earthquake that very rarely occurs (once in 100 years)

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Revision of the Law, with Earthquake as a Trigger

In Japan, a country of earthquakes, large scale earthquake disasters have trigged the strengthening of earthquake resistance standards. The base of the current standards were introduced in 1980.

Earthquake	Revision of the Law
The Tokachi-Oki Earthquake (1968) Many cases of damage to RC buildings M 7.9, 49 deaths, 673 buildings collapsed	Introduction of new earthquake resistance standards (1980) ・New provisions of two-step structural calculation ・Increase of the shear wall area for wooden buildings
The Miyagi-Oki Earthquake (1978) Damage to the buildings with pilotis or large eccentricity M 7.4, 27 deaths, 651 buildings collapsed	
The Great Hanshin-Awaji Earthquake (1995) Damage or collapse of the buildings with old earthquake resistance standards or poorly constructed M 7.2, 6,432 deaths, 104,906 buildings collapsed	Introduction of interim inspection (1998) (reference) Introduction of the Law for Promotion of Seismic Retrofitting of Buildings (1995)

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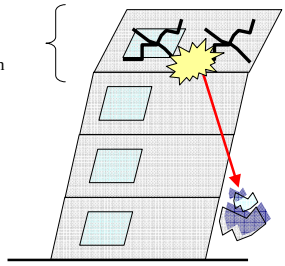
Method of Structural Calculation introduced in 1980

Consideration of Story Deformation Angle

Floor with significant deformation



Story deformation angle: Deformation of each floor

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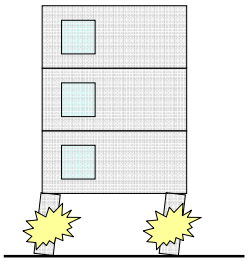
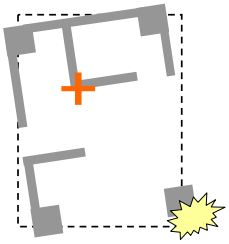
Method of Structural Calculation introduced in 1980

Consideration of Stiffness Ratio and Eccentricity Ratio



Stiffness ratio: Balance of each floor's stiffness



Eccentricity ratio: Balance of each floor's stiffness in horizontal plane

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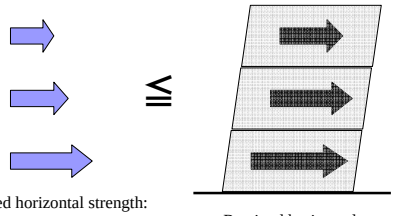
Method of Structural Calculation introduced in 1980

Retained Horizontal Strength



Required horizontal strength: Horizontal strength required for each floor in the event of a large earthquake

Retained horizontal strength: Horizontal force that each floor's columns, beams, and shear walls can bear

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Issue 1

Defects due to poor or negligent construction cause buildings are not constructed in compliance with the earthquake resistance standards

- ✶Work in the natural environment, unlike the case of industrial products
- ✶No buildings are the same
- ✶Many people involved

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Interim Inspection System - 1

In the Great Hanshin-Awaji Earthquake, significant damage occurred due to defects caused by poor or negligent construction.

The Building Standards Law mandates an interim inspection during the construction period and specifies that the local government shall determine its details.
(Central government mandates an interim inspection to apartment houses exceeding three stories)

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Interim Inspection System - 2

In response, Tokyo Metropolitan Government (TMG) sets the most stringent standards in Japan.

- Buildings subject to the interim inspection
  - All buildings with three stories or more, regardless of the structure type
- Target of the interim inspection
  - Wooden buildings: Roof construction
  - Steel or steel reinforced concrete buildings: Frames of the first floor
  - Reinforced concrete buildings: Floor construction of the second floor
  - ※ Buildings with a total floor area exceeding 10,000 m^2: Foundation is required

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Issue 2

There still remain many buildings that do not meet the current earthquake resistance standards

∗ Earthquake resistance standards are becoming increasingly stringent in light of earthquake damage, changes in the social economy and the spread of new technologies.

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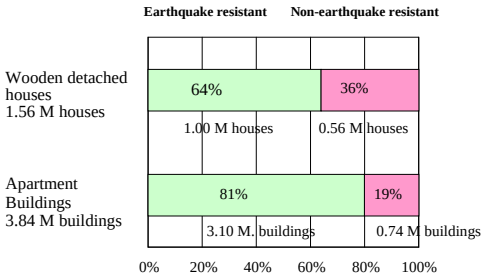
Current Status of Earthquake Resistant Residential Buildings

There still remain many residential buildings in the Tokyo Metropolis that do not meet the new earthquake resistance standards.



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Establishment of the Law for Promotion of Seismic Retrofitting of Buildings

- At the Great Hanshin-Awaji Earthquake, many buildings built before 1980 suffered severe damage
- Strengthening seismic resistance performance of buildings nonconforming current standards are the critical issue
- In October 1995, Enacted the Law for Promotion of Seismic Retrofitting of Buildings

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Outline of the Law for Promotion of Seismic Retrofitting of Buildings

- The owner of buildings used by general public shall endeavor to consult seismic diagnosis and retrofitting
- Approved seismic retrofitting shall not influence any disqualification other than seismic resistant requirement
- Local governments shall establish Seismic Retrofitting Promotion Plan

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Issue 3

There are architects who falsify the structural calculation so that the earthquake resistance standards are not met

∗Deterioration of the trust in architects holding a national license

∗Lack of professional ethics as an engineer

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Structural Calculation Sheet Forgery Case

Mr. Aneha, a first-class architect, forged structural calculation sheets to cut costs and reduce construction time

- 99 cases of forgeries were found nationwide
- Cause large damages to the residents of the falsified apartment buildings
- The development of structural calculation sheets is sophisticated and complicated

  Utilization of computers → Difficulty in detecting a forgery

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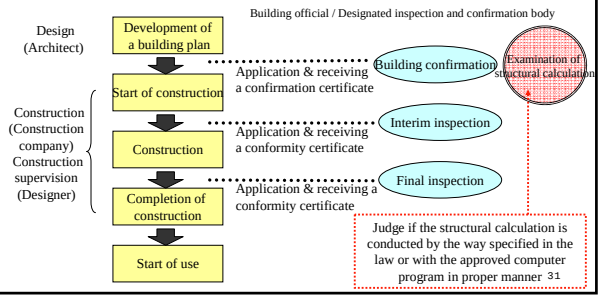
Revision of the Building Standard Law Enforced in June 2007

1 More stringent building confirmation and inspection

- Buildings of a certain height or higher → Examination of structural calculation



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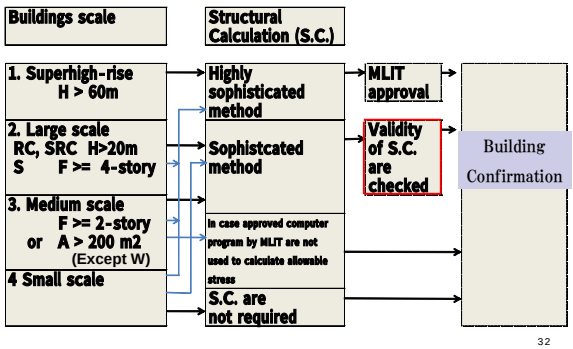
Buildings requiring "Examination of Structural Calculation"



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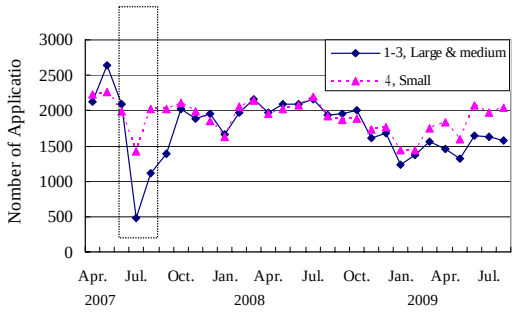
Number of Application for Building Confirmation (Except Plan Change)



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Revision of the Building Standard Law Enforced on June 2007

2 Penalty strengthened in relation to the work of architects, etc.

Details of violation	Before revision	Revised
Violation of significant substantive provisions, such as the earthquake resistance standards	Fine of ¥500,000	3 years imprisonment / fine of ¥3 million (¥100 million for a corporation)

3 Disclosure of information on architects and architect offices

◆ Public disclosure of the names of architects and architect offices punished, etc.

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Revision of Registered Architect System (To ensure the necessary quality and capability)

Registered First-class Architect

Periodic training (1 day every 3 years), **Contents** (law revision, construction technology), **Completion examination** (true-false test)

5 years or more design experience in structure / equipment design

3 years or more design experience

⑥ **Training for first-class architects of structure / equipment design:** Lecture (3 – 4 days) and completion examination (in description style)

⑦ **Training for first-class architects of structure / equipment design:** Lecture (1 day every 3 years) and completion exam (true-false test)

⑧ **Training for managing architects:** Lecture (3 – 4 days) and completion exam (true-false test)

The involvement of registered first-class architects is required for the structure / equipment design of large scale buildings from May 2009

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Thank you for your kind attention

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