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Guide to Earthquake-Resistant Buildings in Japan

By Yasuharu Matsuno, Last Updated On June 2, 2023

How does a country frequently subjected to seismic activities like Japan ensure the safety of its buildings and residents? The answer lies in the construction of earthquake-resistant buildings, a practice that has become an essential aspect of Japanese architecture.

The Building Standard Act, which is regularly reviewed and updated, ensures that all structures are designed and built to withstand earthquakes. This stringent adherence to earthquake-resistance standards has resulted in a low collapse rate of buildings during powerful earthquakes in Japan, compared to other countries.

In this article, we delve into the evolution of building laws and regulations in Japan, the specifics of earthquake-resistant buildings, and how to verify these features when selecting a building. We will also discuss the various types of building structures in Japan, their characteristics, and their performance during earthquakes.

Evolution of Japan's Earthquake Resistance Laws and Regulations

1971: Enhancing Standards for RC Structures

Following the 1968 earthquake off the coast of Tokachi, which registered a maximum JMA seismic intensity scale of 5, the standards for tie-hoops of RC (reinforced concrete) structures were enhanced.

Damage from the 1968 Tokachi Earthquake: Collapsed Building in Japan

1981: Implementation of New Anti-seismic Design Standard

The earthquake off the coast of Miyagi Prefecture in 1978, which also registered a maximum JMA seismic intensity scale of 5, led to a revision of the Building Standard Act. The New Anti-seismic Design Code was introduced, focusing not only on preventing building collapse during earthquakes but also on ensuring the safety of the occupants.

Damage from the 1978 Miyagi Earthquake: Collapsed Building in Sendai

2000: Strengthening Standards for Wooden Structures

The devastating Great Hanshin Earthquake of 1995, which reached a maximum JMA seismic intensity scale of 7, prompted another revision of the Building Standard Act. This revision aimed to enhance the safety of wooden buildings and clarify anti-seismic performance levels, specifications, and building foundation forms. Ground investigations became virtually mandatory.

Collapsed Mitsubishi Bank Hyogo Branch Building following the Great Hanshin-Awaji Earthquake in 1995

With the implementation of the Housing Quality Assurance Promotion Act (Housing Quality Assurance Act), the "Housing Performance Labeling

System" was established. This system allowed for the evaluation and comparison of housing performance based on unified standards. Additionally, construction companies were held accountable for defects and rain leaks in the basic structural parts of the house for a period of 10 years.

	1971	1981	2000
Amendment	Enhanced RC structure standards post-Tokachi earthquake.	New Anti-seismic Design Standard introduced post-Miyagi earthquake.	Strengthened wooden structure standards post-Great Hanshin Earthquake.

Table 1: Timeline of Key Amendments to Earthquake Resistance Standards in Japan

Understanding Anti-seismic Performance Levels

1. "Building Standard Act: Earthquake Resistance Standards" – Safeguarding Human Life

The earthquake resistance standards set by the Building Standard Act were made stricter following the revision of the Act on June 1, 1981. The standards prior to this date are referred to as the old earthquake resistance standards, while those after this date are known as the new earthquake resistance standards.

- **Old Earthquake Resistance Standards:** Buildings are designed to withstand an earthquake of JMA seismic scale 5+ without collapsing.
- **New Earthquake Resistance Standards:** Buildings are designed to sustain minimal damage from an earthquake of JMA seismic intensity scale 5+ and to withstand an earthquake of JMA seismic intensity scale 6+ to 7 without collapsing.

To verify the earthquake resistance standards of a building, note that the new standards apply to buildings that received building certification on or after June 1, 1981. The building certification system ensures that a building plan complies with the building standards set by laws and regulations before construction begins. For condominiums, the construction period typically lasts about 1 to 1.5 years from the time of receiving building certification to completion. Therefore, condominiums completed in 1981 are likely to meet the old earthquake resistance standards. The date of building certification can be checked at the municipal office, so it's recommended to verify this with a real estate company for condominiums completed between 1981 and 1983.

2. "Housing Quality Assurance Act: Seismic Grade"

The "Housing Performance Labeling System" based on the "Housing Quality Assurance Promotion Act (Housing Quality Assurance Act)" enforced in 2000, provides a seismic grade. This grade evaluates the quake-resistance performance of a house on three levels based on two indices: "damage prevention" and "prevention of collapse, etc." The higher the grade, the better the quake-resistance performance.

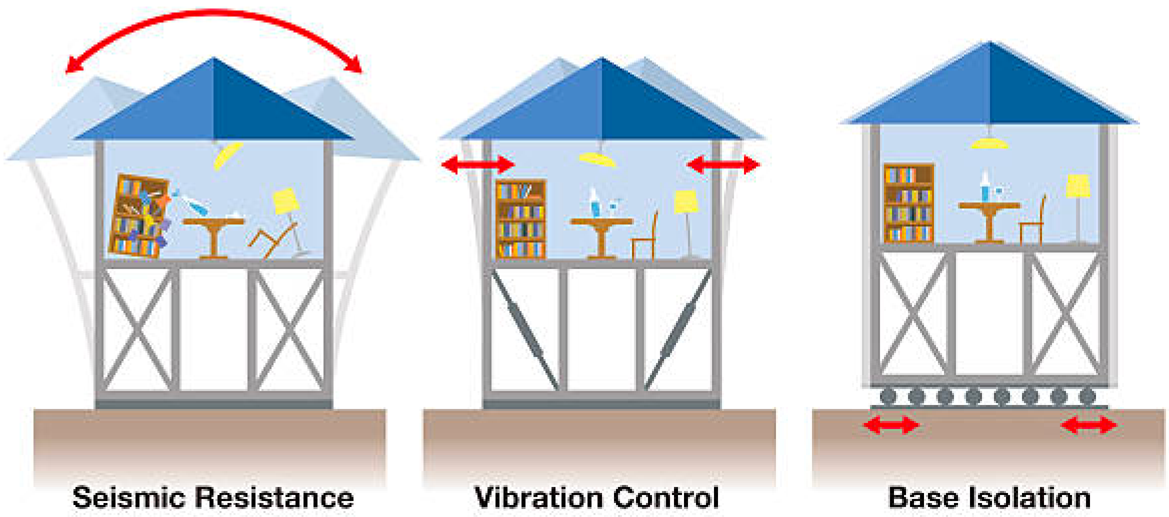
- **Damage Prevention:** This refers to a seismic performance level that can withstand an earthquake that may occur once every few decades (JMA seismic scale 5+) to the extent that large-scale restoration is not required.
- **Prevention of Collapse, etc.:** This refers to a seismic performance level that protects human life even if the damage is received from an earthquake that may occur once every few hundred years (JMA seismic intensity scale 6+ to 7).

- **Seismic Grade 1:** This level is equivalent to the earthquake resistance standards set by the Building Standard Act. Buildings at this grade are designed to sustain minimal damage from an earthquake with a JMA seismic intensity scale of 5+ and to withstand an earthquake with a scale of 6+ to 7 without collapsing. However, buildings may sustain damage from an earthquake with a scale of 6+ or higher to the extent that they need to be rebuilt.
- **Seismic Grade 2:** This grade represents a quake-resistance performance level that can withstand an earthquake 1.25 times as intense as the performance level assumed by Seismic Grade 1. Buildings with Seismic Grade 2 may sustain damage from an earthquake with a seismic intensity scale of 6+ to 7, but the damages are considered repairable. Buildings with Seismic Grade 2 or higher can be certified as "Long-life quality housing", which are designed for safe and comfortable living over a long period of time, and are eligible for various tax incentives.
- **Seismic Grade 3:** This is the highest grade and represents a quake-resistance performance level that can withstand an earthquake 1.5 times as intense as the performance level assumed by Seismic Grade 1. This grade level is required for critical facilities like fire stations and police stations that serve as the center for reconstruction and first-aid activities in the event of a disaster. Buildings with Seismic Grade 3 may

sustain damage from an earthquake with a seismic intensity scale of 6+ to 7, but the damages may be minor and are considered repairable.

To verify the Seismic Grade of a building, you can check with the house builder or the builder office for a newly built house, or inquire with the development company for a newly built condominium. For pre-owned houses and apartments, you can ask the construction company or the management company via real estate agents.

How Building Structure Influences Seismic Resilience in Japan



Earthquake Resistant Structure

This is the most prevalent structure for detached houses in Japan. All buildings constructed after 1981 must comply with the New Anti-seismic Structure Standard, which requires buildings to have an earthquake resistance structure. This structure allows the main building structures, such as posts, walls, and floors, to absorb seismic motions. Buildings can be categorized into Rigid Structure (constructed rigidly to prevent collapse) and Flexible Structure (where the main structural parts bow flexibly to distribute the force of seismic motions).

Vibration Control Structure

To minimize seismic motion, damping walls that absorb seismic energy are built within the structure. Vibration Control structures can be categorized into the Active type, which uses energy such as electricity, and the Passive type, which uses physical forces. Compared to earthquake-resistant structures, Vibration Control Structure structures can reduce seismic intensity by 70-80%.

Seismic Isolation Structure

This structure is commonly used for high-rise buildings as part of their foundation. It places quake-absorbing devices (isolators) such as laminated rubber that blocks seismic motions from reaching the building. Quake-absorbing devices include laminated rubber, lead, springs, dampers, ball bearings, etc. Furthermore, newly-invented construction methods use a combination of these materials. Seismic isolation structure can reduce seismic intensity down anywhere from ⅓ to ⅕ (less than half) when compared to earthquake resistant structure.

In general, apartment and office buildings with damping or seismic isolation structures are more secure against earthquakes compared to those with more basic anti-seismic structures.

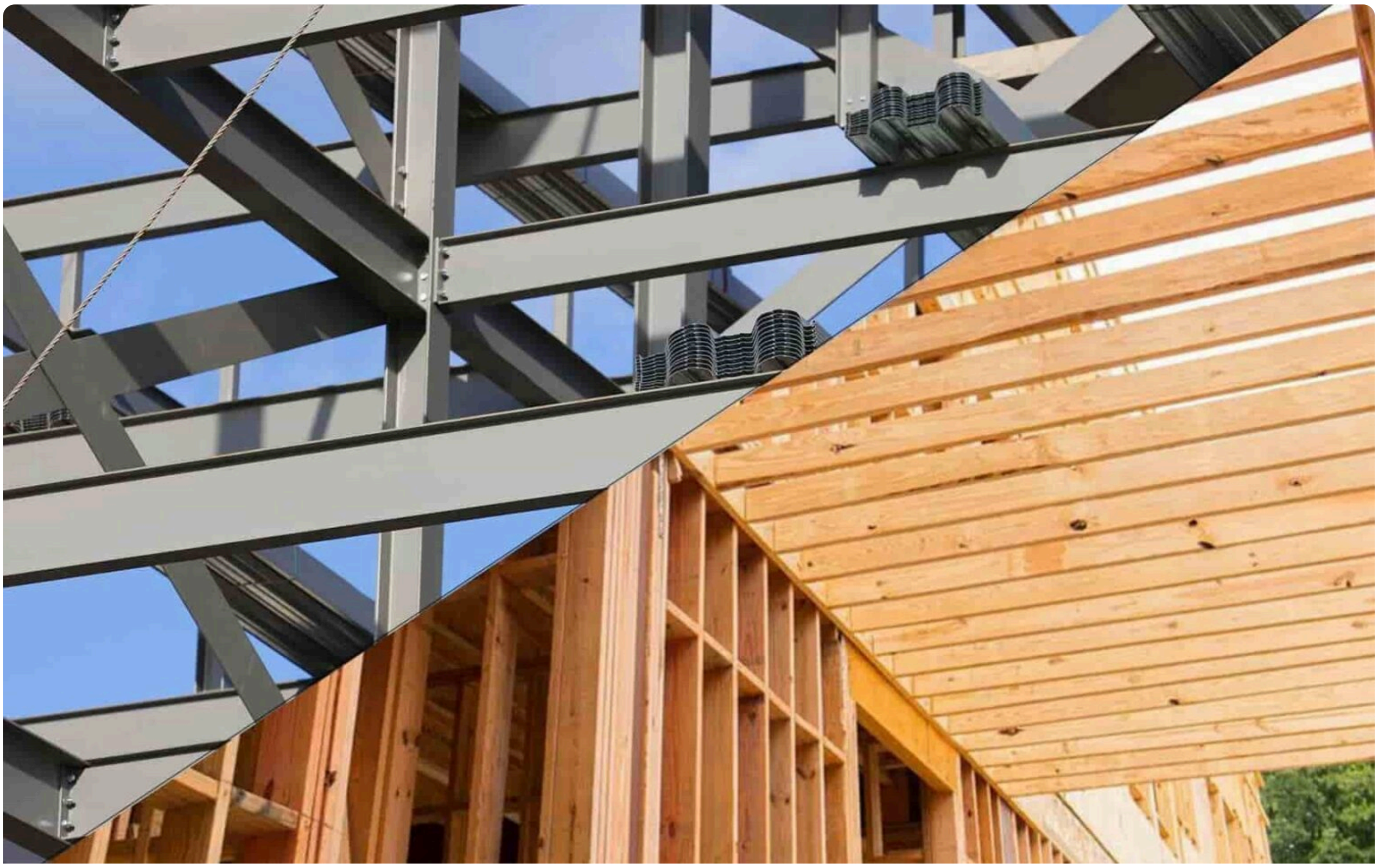
Exploring the Variety of Building Structures and Materials in Japan

Wooden Structure

Wood is the primary material used in these buildings. In this structure, posts and beams serve as the core parts of a building. Many detached houses in Japan are made of wood.

Steel Structure (S)

This refers to buildings primarily using steel materials in their framework. Steel structures are especially suitable for large buildings.



Steel vs Wooden Structures

Reinforced Concrete Structure (RC)

Building frameworks outfitted with RC (Reinforced Concrete) structure utilize concrete with iron reinforcing bars inside. RC structure takes advantage of both reinforcing bars as well as a steel frame. With Reinforced Concrete structure, steel-made “reinforcing bars” with tolerance against stretching forces, strengthen the “concrete” which resists the compressive forces of the building’s weight.

Construction site of a Reinforced Concrete (RC) Building in Japan

Steel Reinforced Concrete Structure (SRC)

Along with iron frames, buildings with this framework primarily employ concrete with iron reinforcing bars inside. This structure, often referred to as "SRC structure," utilizes both steel and reinforced concrete. Iron poles and beams, which are further supported by iron reinforcing bars, are later filled with concrete. This structure is often applied for high-rise buildings because it provides excellent seismic resistance and is also solid and durable.

In general, apartment and office buildings with damping or seismic isolation structures are more secure against earthquakes compared to those with more basic anti-seismic structures.

Structure Type	Description
Wooden Structure	Wood is the primary material used in these buildings.
Steel Structure (S)	Buildings primarily using steel materials in their framework.
Reinforced Concrete Structure (RC)	Building frameworks outfitted with RC (Reinforced Concrete) structure utilize

Structure Type	Description
	concrete with iron reinforcing bars inside.
Steel Reinforced Concrete Structure (SRC)	Along with iron frames, buildings with this framework primarily employ concrete with iron reinforcing bars inside.

Table 2: Summary of Different Types of Building Structures and Materials Used in Japan

Assessing Earthquake Damage Risk Across Different Areas in Tokyo

The risk of earthquake damage varies depending on the ground, the shape of the land, the density of buildings, and other factors.

In Tokyo, high-risk areas are located on the ground and classified as alluvial plains or lowland valleys such as fan-shaped lands, natural levee zones, deltas, and are distributed throughout the old downtown area along the [illegible]r, where old wooden and lightweight steel frame buildings are densely gathered.

Specifically, the Southern Adachi ward, Arakawa ward, Eastern Taito ward, Western Katsushika ward, Sumida ward, and Northern Koto ward areas are considered higher risk due to the reasons described above.

On the other hand, Chiyoda Ward, Minato Ward, Shibuya Ward, etc., where many government offices and foreign companies are located, are considered relatively safe areas in Tokyo.

Area	Risk Level
Southern Adachi ward, Arakawa ward, Eastern Taito ward, Western Katsushika ward, Sumida ward, Northern Koto ward	High
Chiyoda Ward, Minato Ward, Shibuya Ward	Low

Table 3: Earthquake Damage Risk Levels for Different Areas in Tokyo

Conclusion

In conclusion, Japan's commitment to seismic resilience is evident in its stringent building standards and innovative architectural practices. From the evolution of building laws and regulations to the different types of earthquake-resistant structures, understanding these aspects is crucial when considering a property in Japan. However, always consult with a real estate professional to ensure the property meets the necessary earthquake resistance standards and seismic grade.

Yasuharu Matsuno

Yasuharu "Yasu" Matsuno is the Co-founder and CEO of Blackship Realty, the operator of Tokyo Portfolio. A leading expert in Japanese real estate investment, Yasu holds an MBA from Columbia University, Class of 2017. With prior experience at Mitsubishi Corporation and years spent abroad, he brings a global perspective to the Japanese real estate market.