

# Recent Mid- and High-Rise Timber Construction in Japan and its Features



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# Background

- Act on promoting the use of wood in public buildings, etc. enforced on 2010 was amended as “Act on promoting the use of wood in buildings, etc. to contribute to the realization of a decarbonized society” on 2021 in Japan.
- In a highly seismic country, Japan, not only the seismic regulation but also the fire-safety regulation is strict due to fires after a large seismic disaster.
- Japan has a hot and humid climate and the activity of wood rotting fungi and termites are high.
- Thus, it is not easy to build using wood meeting the current performance requirements, although most houses are built in wood and Japan has a great culture of wooden construction with over 1000 years of history.

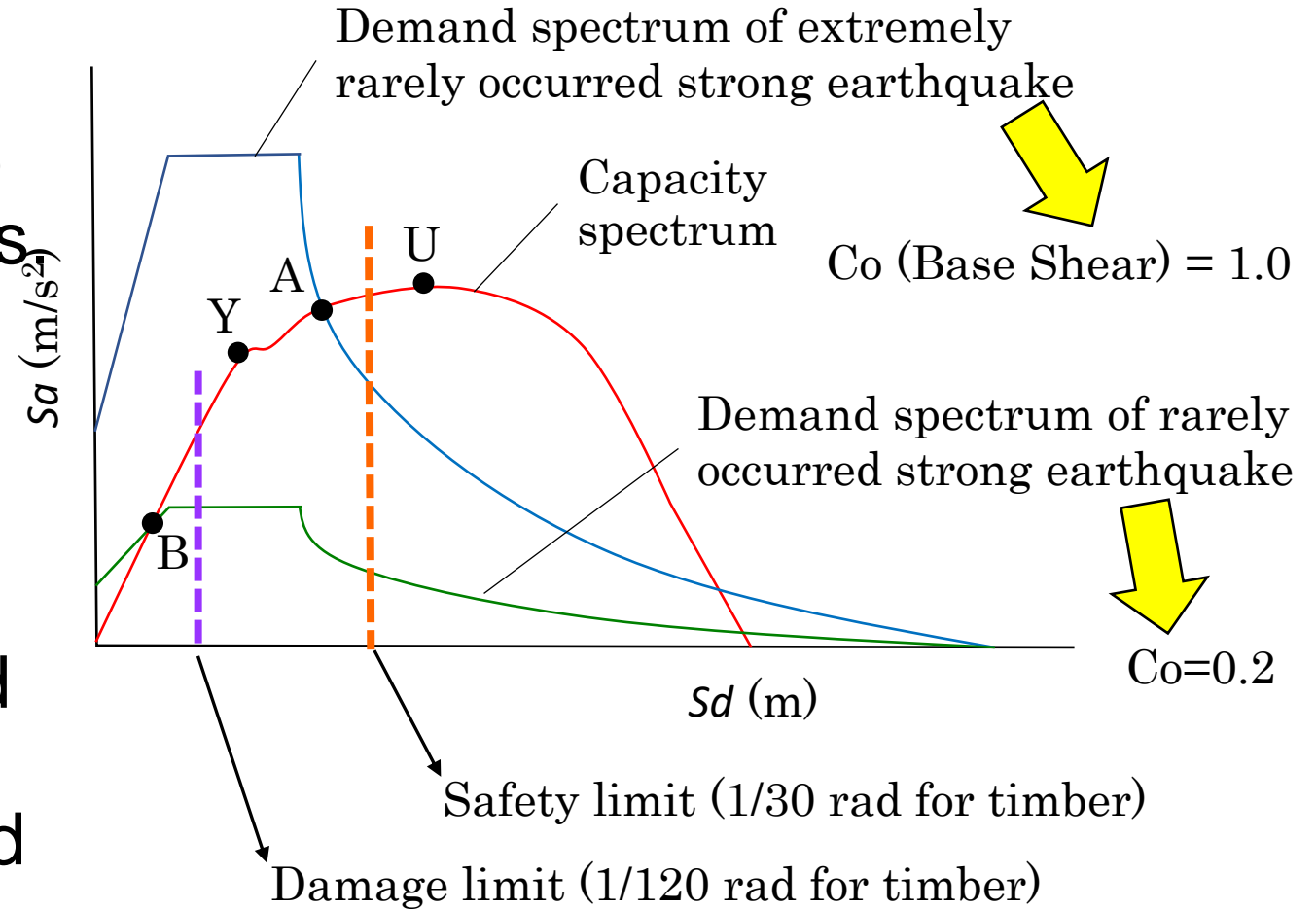
# Seismic Requirements in Japan

Japan is one of the highest seismic countries.

The Building Standard Law (BSL) provides the seismic requirements

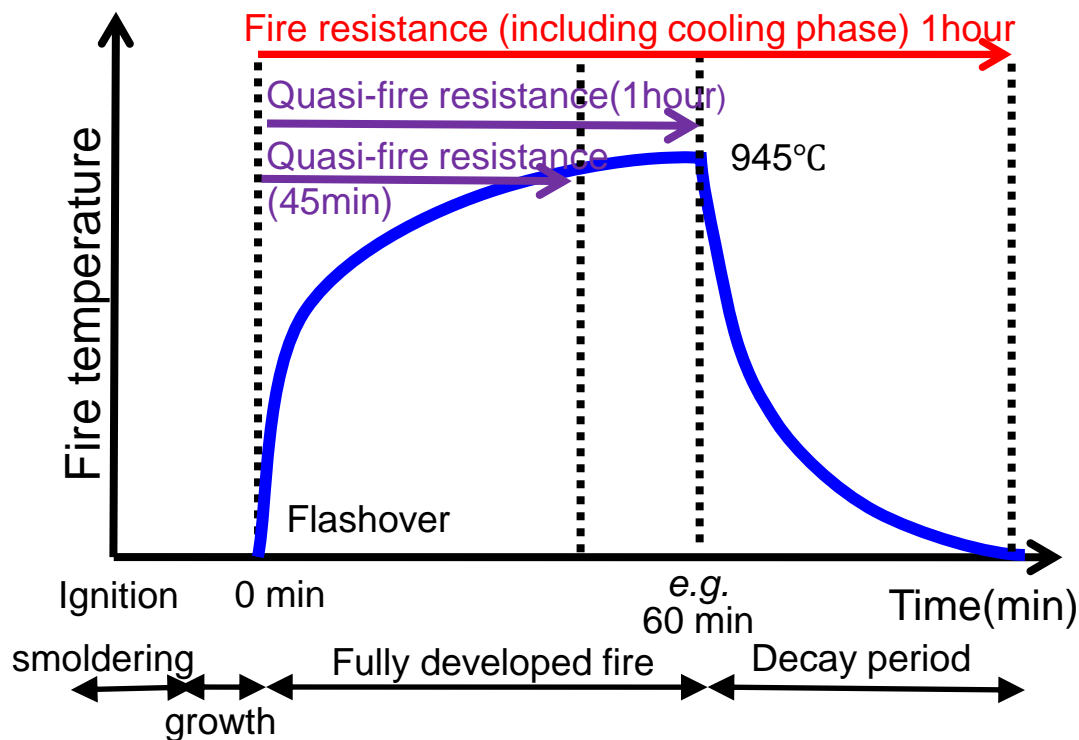
- Under rarely occurred earthquakes (once in 50 years): no deformation beyond damage limit.
- Under extremely rarely occurred earthquakes (once in 500 years): no collapse (not to deform beyond safety limit).

In other words of capacity spectrum method

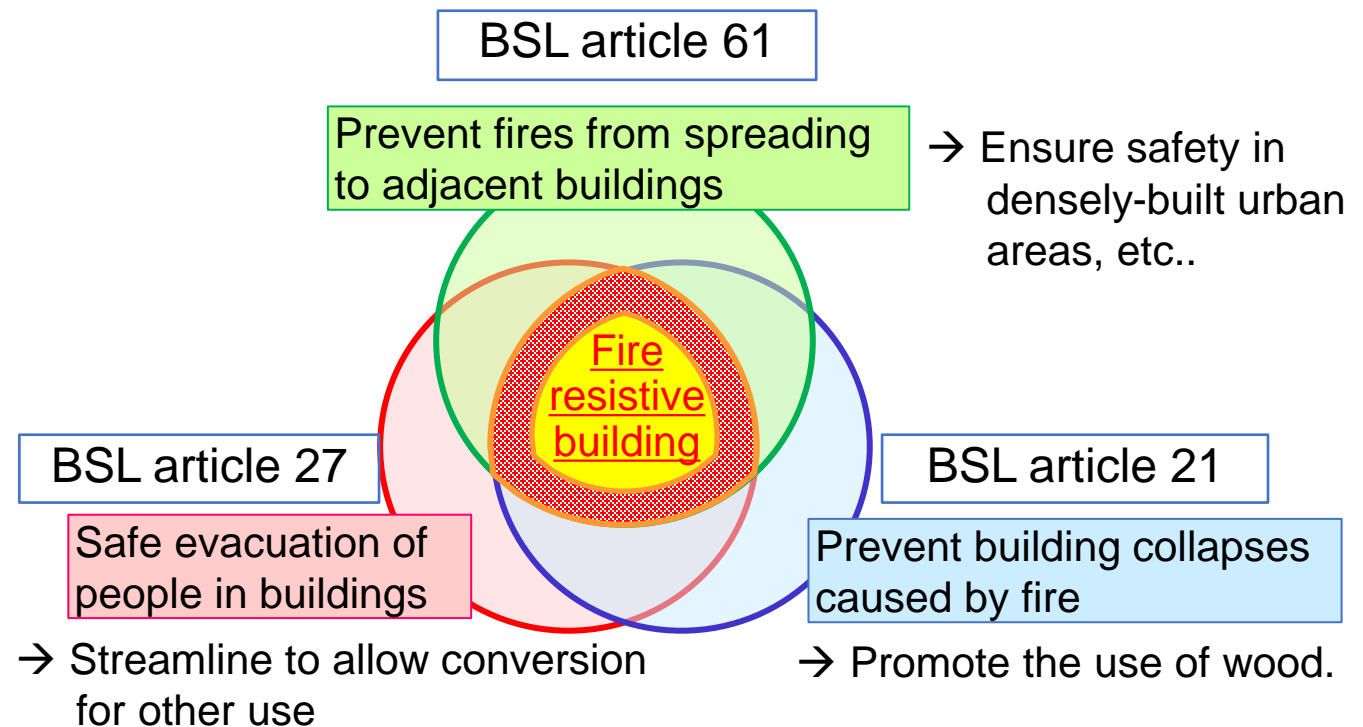


# Fire safety requirements for timber structural members

Definition of fire resistance and quasi-fire resistance performance



For promoting wood utilization and securing fire safety, quasi-fire resistive construction is expanded.



Broaden the freedom of design

# Regulations for fire prevention areas and quasi-fire prevention areas

Number of floors	Fire preventive district			Quasi-fire preventive district		
	≤50 m <sup>2</sup>	≤100 m <sup>2</sup>	Over 100 m <sup>2</sup>	≤ 500 m <sup>2</sup>	Over 500 m <sup>2</sup> & ≤ 1,500 m <sup>2</sup>	Over 1,500 m <sup>2</sup>
Over 4	<div style="border: 2px dashed red; padding: 10px;"> <p style="text-align: center;">Fire resistive building</p> <div style="border: 1px solid red; border-radius: 10px; padding: 5px; display: inline-block; margin: 10px auto; width: 200px;">                     + Equivalent building to Fire resistive building by performance-based verification                 </div> <p style="text-align: center; margin-top: 20px;">Fire resistive building</p> </div>					
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2	<div style="border: 2px dashed red; padding: 10px;"> <div style="border: 2px dashed blue; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Quasi--Fire resistive building</p> <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; display: inline-block; margin: 10px auto; width: 200px;">                     + Equivalent building to Quasi-Fire resistive building by performance-based verification                 </div> </div> <div style="border: 2px dashed green; padding: 5px; margin-bottom: 10px; display: inline-block; width: 150px;"> <p style="text-align: center;">Buildings with specific fire protections</p> </div> <div style="border: 2px dashed yellow; padding: 5px; margin-bottom: 10px; display: inline-block; width: 150px;"> <p style="text-align: center;">Fireproof construction</p> <div style="border: 1px solid blue; border-radius: 10px; padding: 5px; display: inline-block; margin: 10px auto; width: 100px;">                     + Equivalent to fireproof construction                 </div> </div> <div style="border: 2px dashed cyan; padding: 5px; margin-bottom: 10px; display: inline-block; width: 150px;"> <p style="text-align: center;">Quasi-Fire resistive building</p> <div style="border: 1px solid cyan; border-radius: 10px; padding: 5px; display: inline-block; margin: 10px auto; width: 150px;">                     + Equivalent building to quasi-fire resistive building by performance-based verification                 </div> </div> <p style="text-align: center;">Fire resistive building</p> </div>					
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# Development of fire resisting structure

Membrane type

Charring stop type

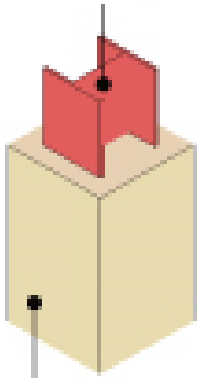
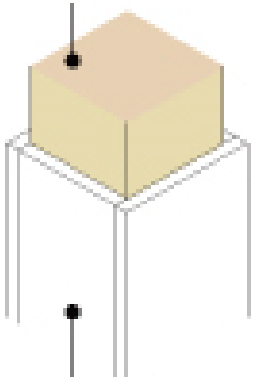
2005 Self-charring-stop type

2008 Self-charring-stop type

2013 Membrane type

Structural element

Steel



Fire resistive cover

Burning margin



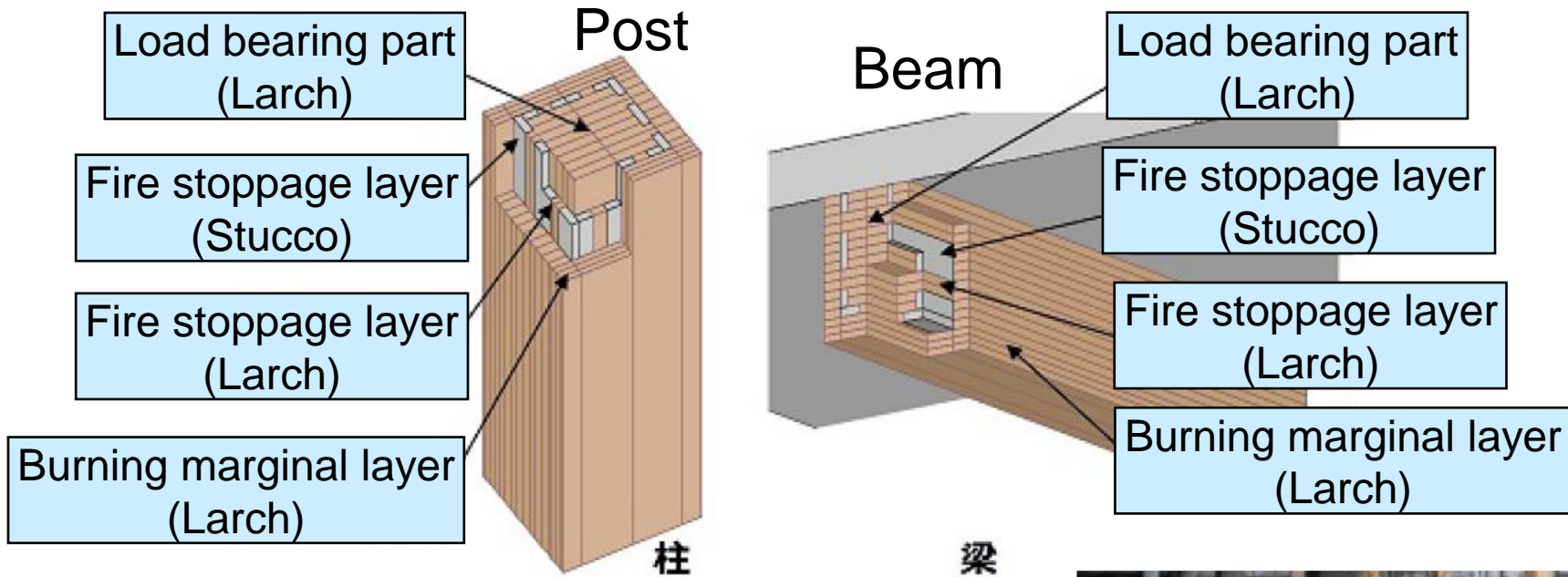
5-story office, Kanazawa

5-story office, Nagoya with 3,244 m<sup>2</sup> of total floor area

5-story apartment house, Tokyo

Café terrace, Tokyo

# Improved self-charring-stop system



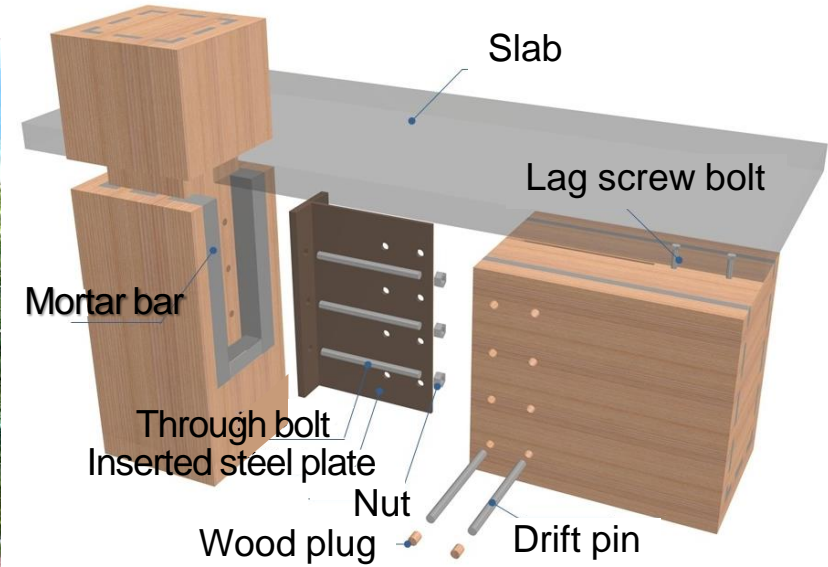
Result of fire test →



Photo: Takenaka Corporation

# Commercial building with self-charring-stop components, 2013

Plan



Completed



Photo: Takenaka Corporation



Photo: Takenaka Corporation

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# Park Wood Takamori, Sendai in 2019

Self-charring- stop post & CLT were installed partially to steel construction

Usage	Residential
Completed	2019
Story	10
Total floor area	3,605.11 m <sup>2</sup>
Building area	519.6 m <sup>2</sup>
Vol. of wood	232 m <sup>3</sup>
Structure	Steel & Wood
Location	Sendai, Miyagi
Design & Constructor	Takenaka Corporation



Photo: Takenaka Corporation

CLT floor panels for 4<sup>th</sup> to 10<sup>th</sup> floor, with fire resistive covering and concrete topping for acoustic performance.

CLT shear walls for 1<sup>st</sup> to 5<sup>th</sup> floor, which support only the vertical load.

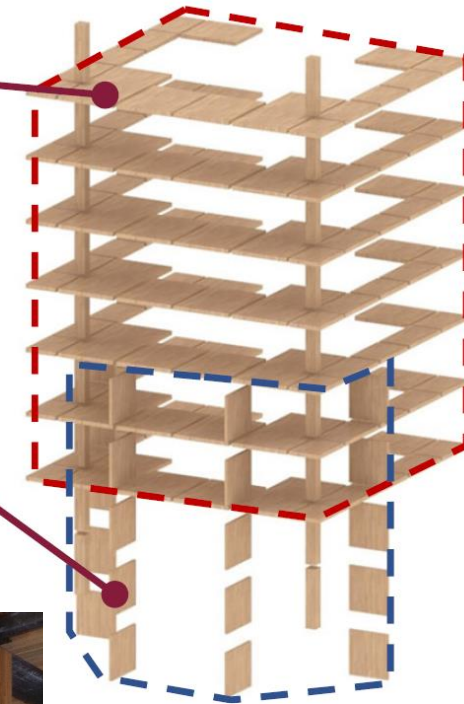
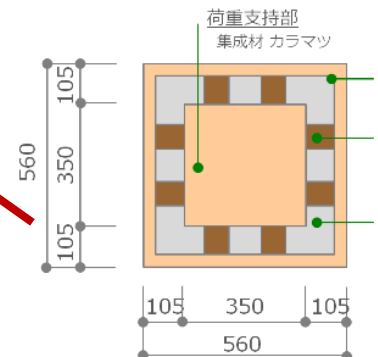


Photo: Takenaka Corporation



# HULIC New Ginza 8

Usage	Office & shop
Completed	2021
Story	12
Total floor area	2,459.55 m <sup>2</sup>
Vol. of wood (m <sup>3</sup> )	Charring stop GLT: 222, GLT: 16, CLT: 50
Structure	Planar mixed structure of steel & wood
Location	Ginza, Tokyo
Design supervision	Kengo Kuma and Associates
Design & Constructor	Takenaka Corporation

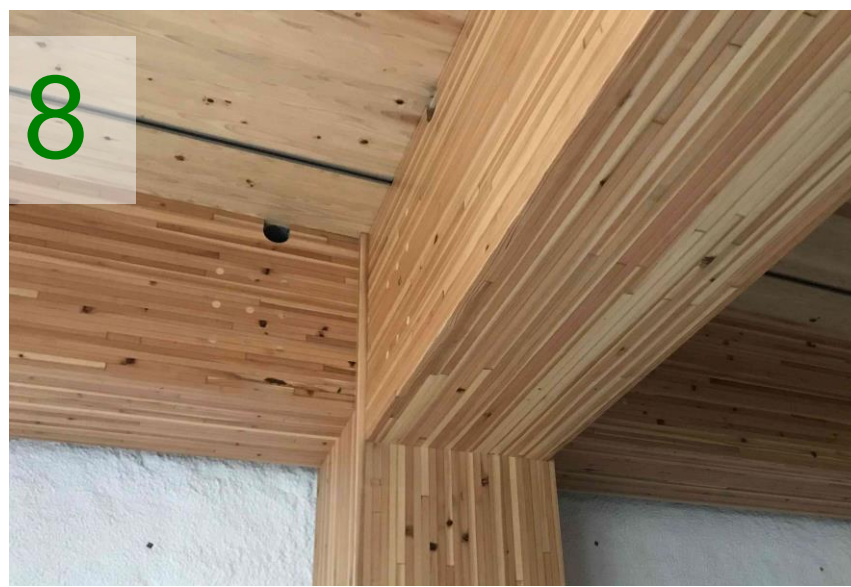
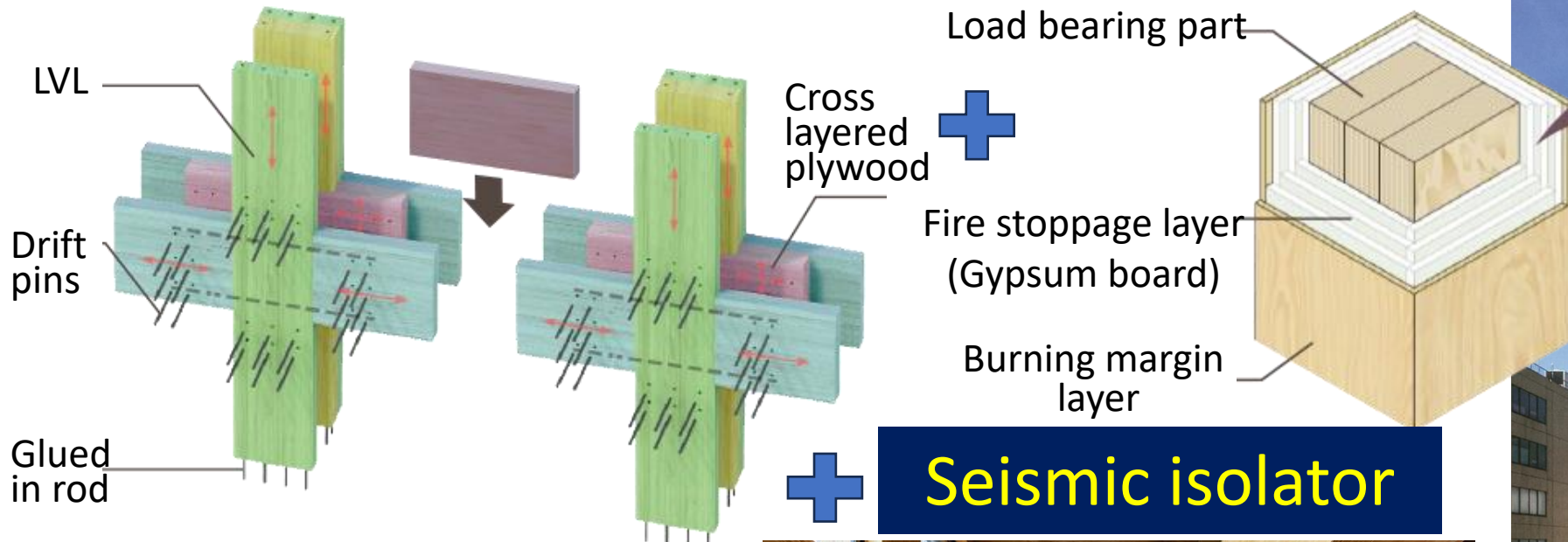


Photo:  
Takenaka Corporation 10

# Port Plus (Employee training center), 2022



# FLATS WOODS KIBA by Takenaka Corporation



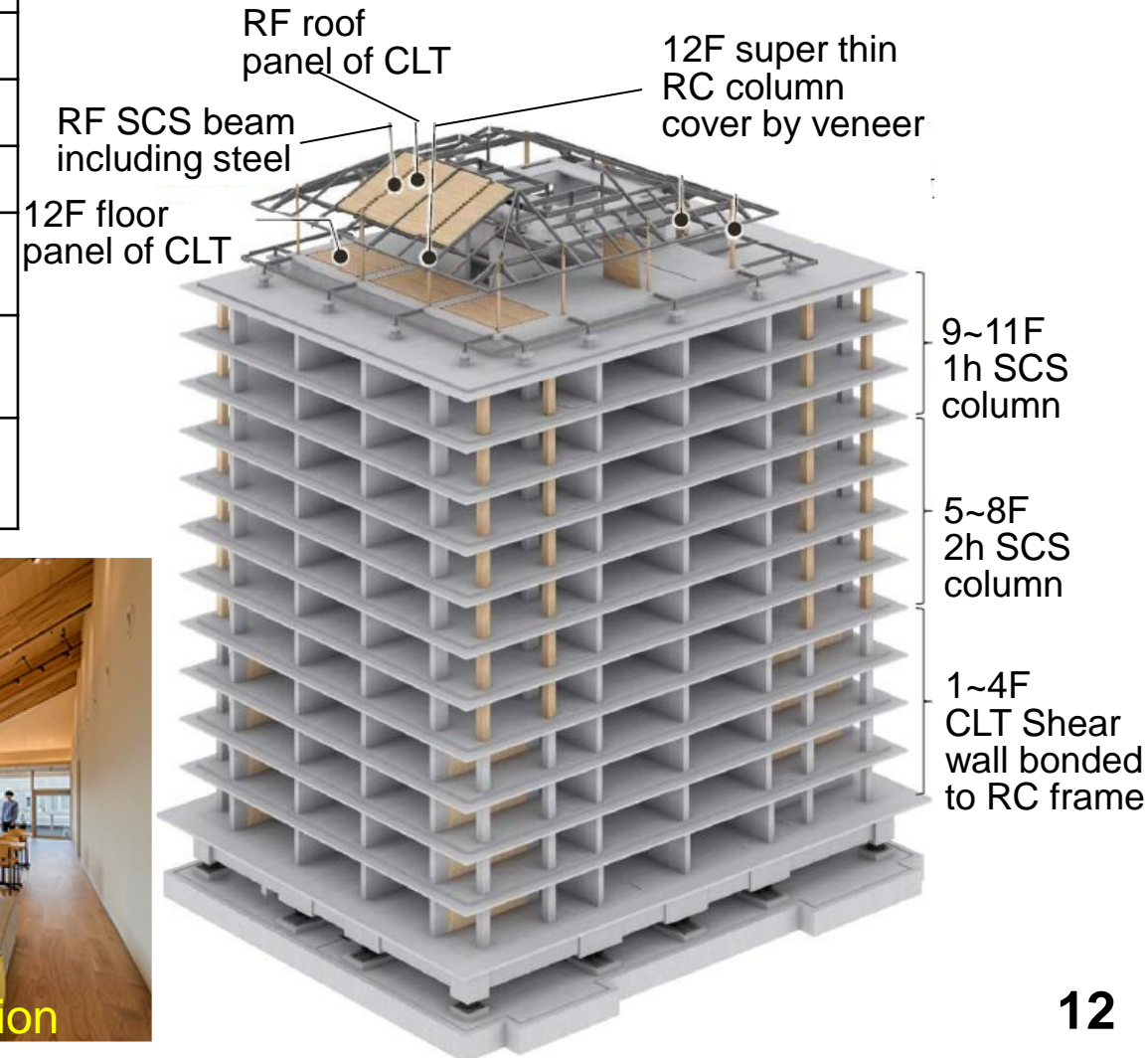
Photo: Takenaka Corporation

Design & constructor	Takenaka Corporation
Location	Toyochō, Tokyo
Completed	Feb., 2020
Story	12
Structure	RC + W with isolator
Building area	914.03 m <sup>2</sup>
Total floor area	9,150.73 m <sup>2</sup>



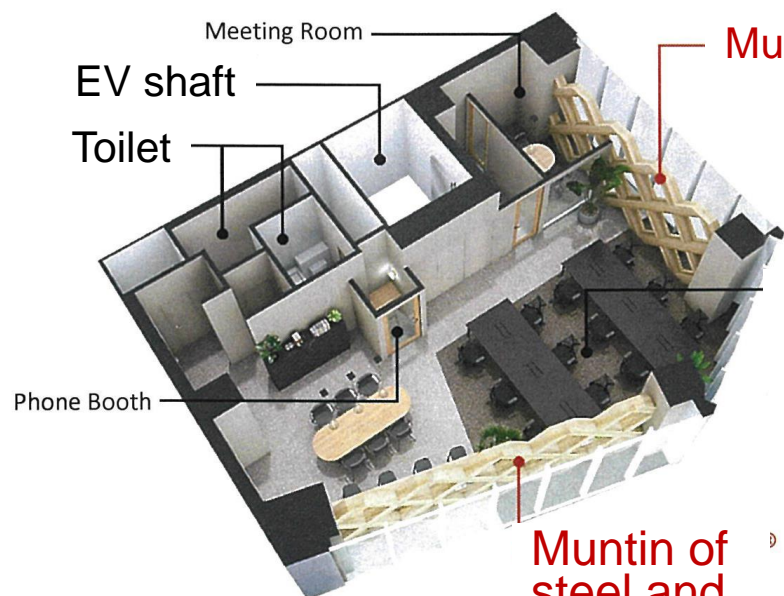
Photo: Takenaka Corporation

## Self-charring-stop → SCS



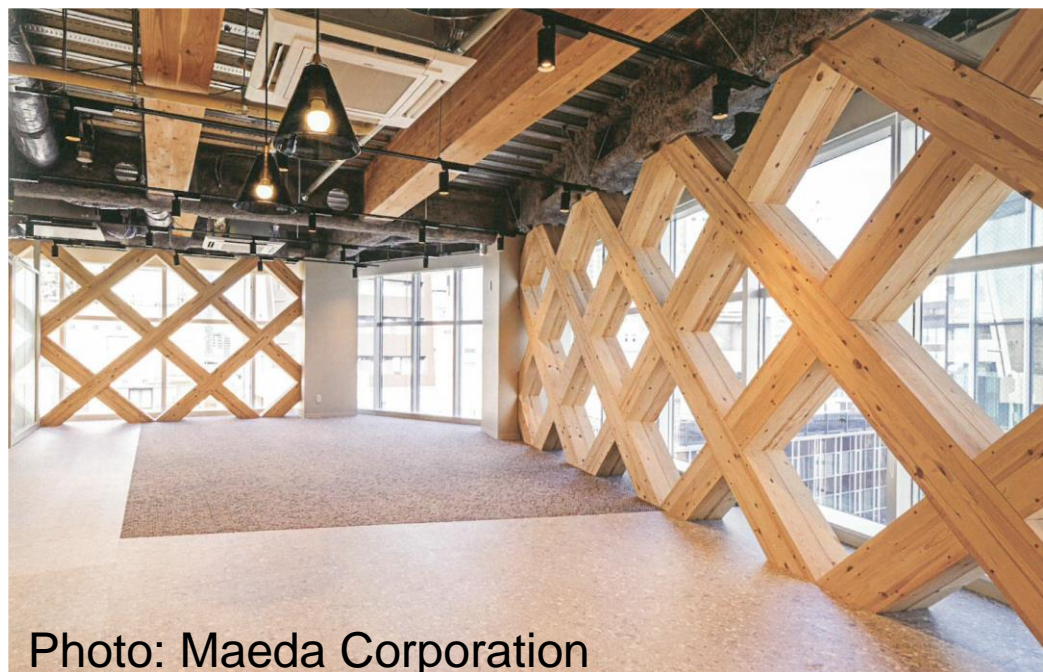
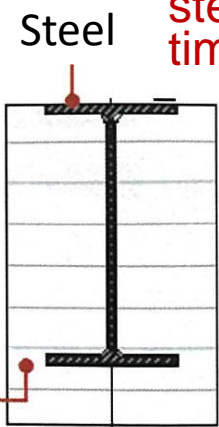
# COERU Shibuya (13-story multiuse building, Hybrid structure, completed in 2022)

Floor plan (office)



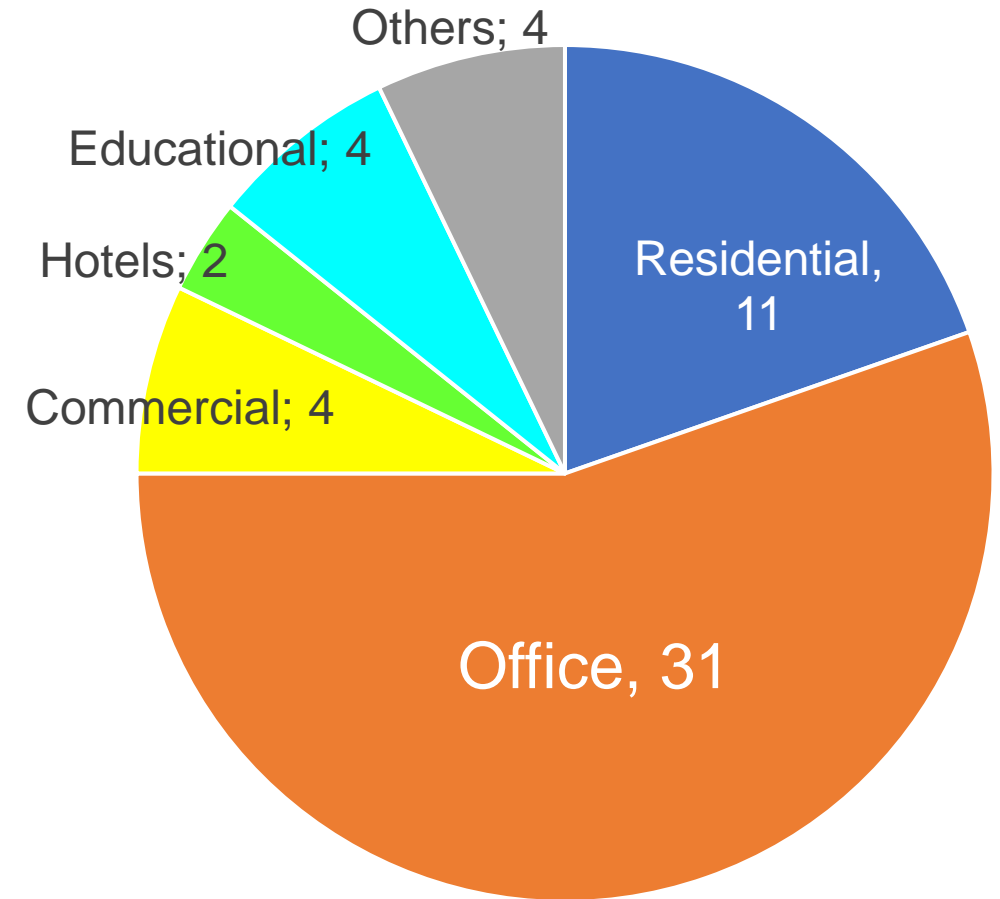
Muntin of steel and timber® on 2<sup>nd</sup> to 13<sup>th</sup> floor as the resisting element against lateral load

Charring stop beams consist of steel and glulam used in 10<sup>th</sup> to 13<sup>th</sup> floor. Glulam of Japanese larch



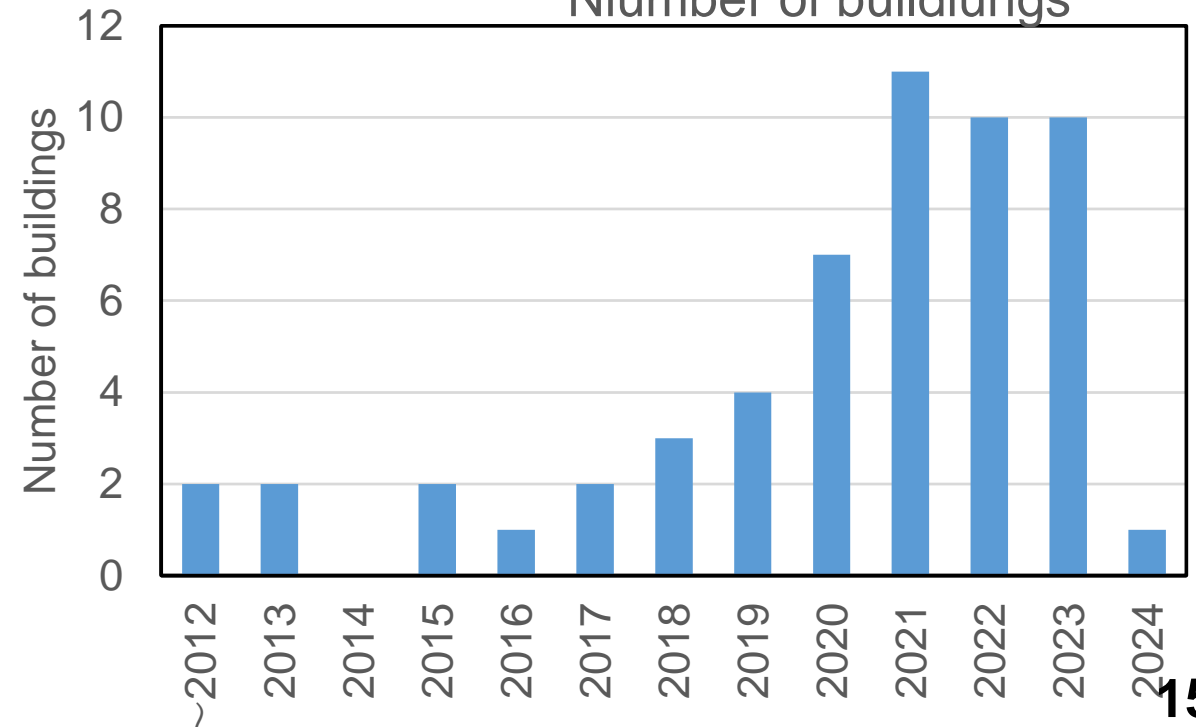
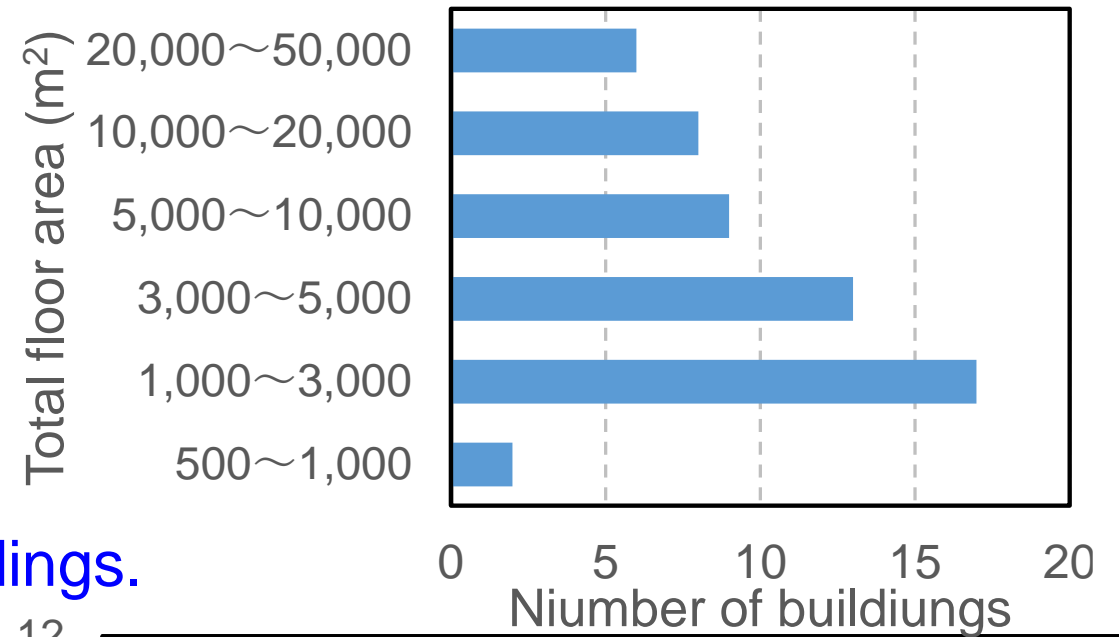
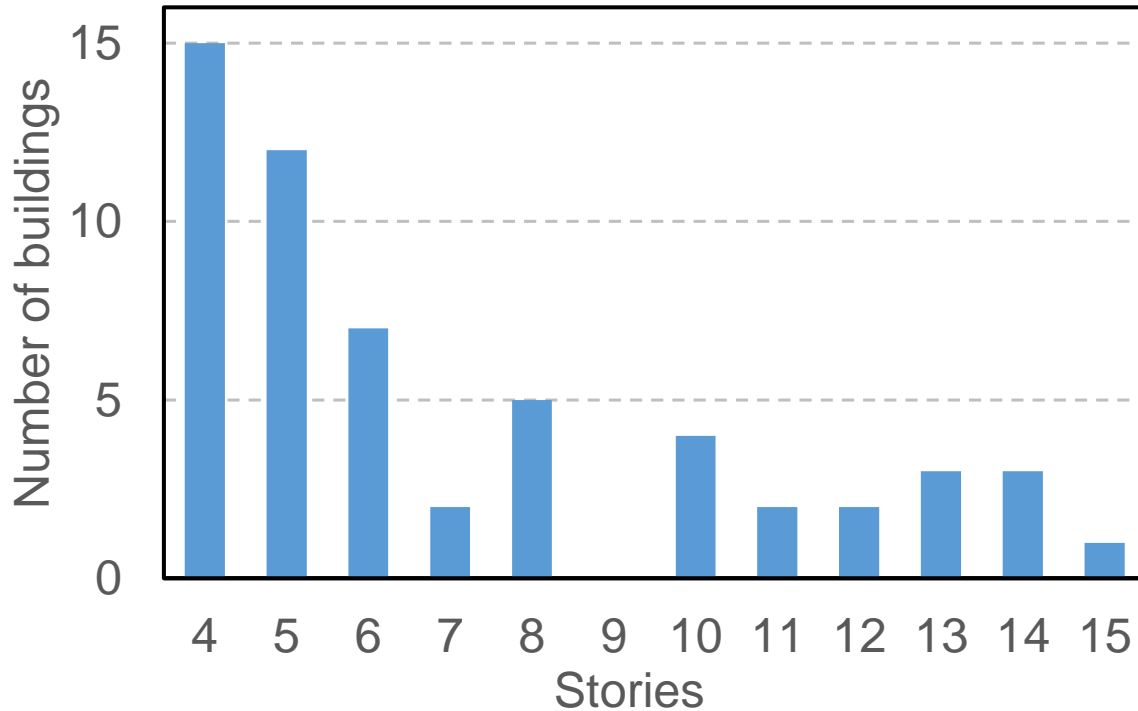
# Survey of over 4 stories timber construction by Japan Federation of Construction Contractors (Nikkenren)

- Nikkenren is a construction industry federation, consisting of general construction companies and their organizations.
- Nikkenren conducted a survey of large-scale and mid- & high-rise buildings including wooden structural members in 2021 and 2022.
- The 56 datum of 4 stories or higher building including wooden structural members were chosen and analyzed.
- The oldest building was completed in 2008, and the newest will be completed in 2024.



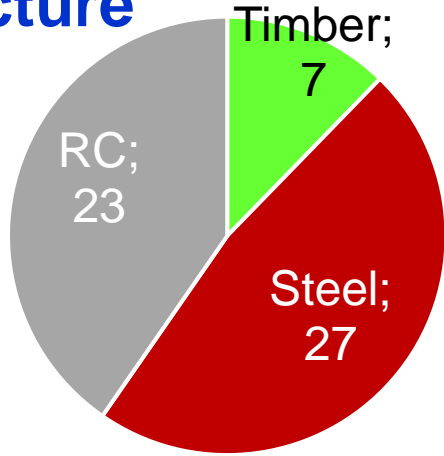
# Stories, total floor area and completion year of 4 stories or higher timber construction

Seismic isolation systems adopted in 11 buildings.



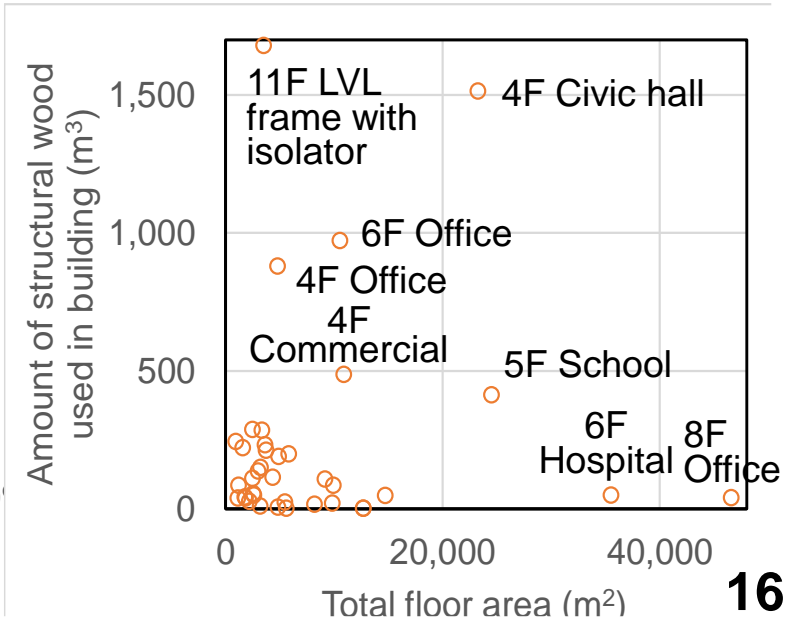
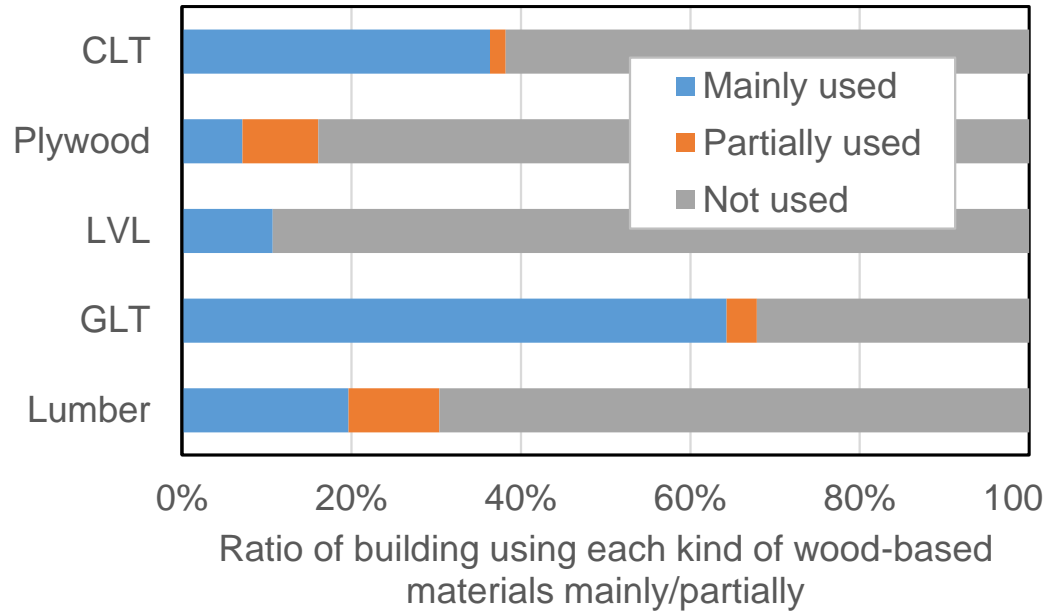
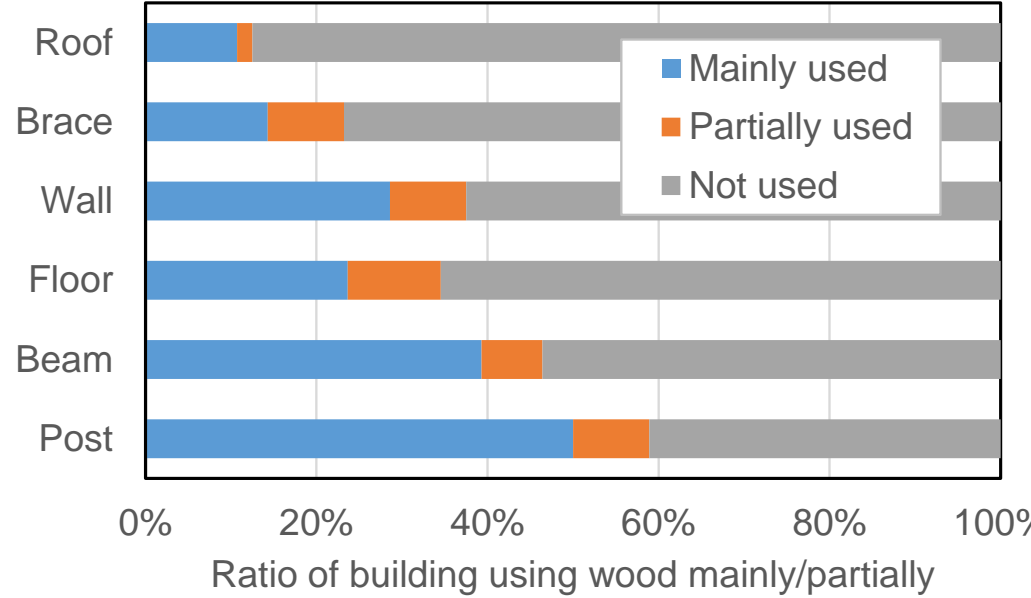
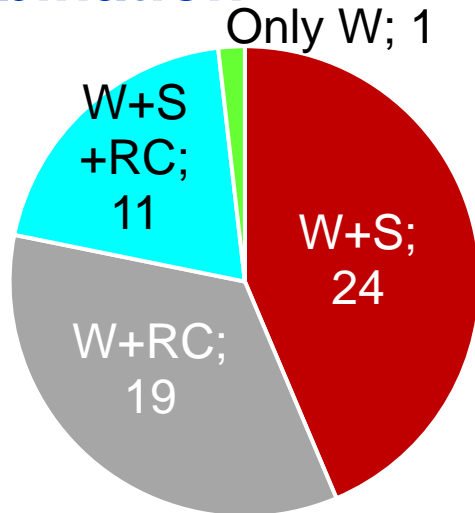
# 4 stories or higher timber construction

## Main structure



Ratio of buildings by the part where wood is used  
 →  
 Ratio of buildings by the use of wood-based materials

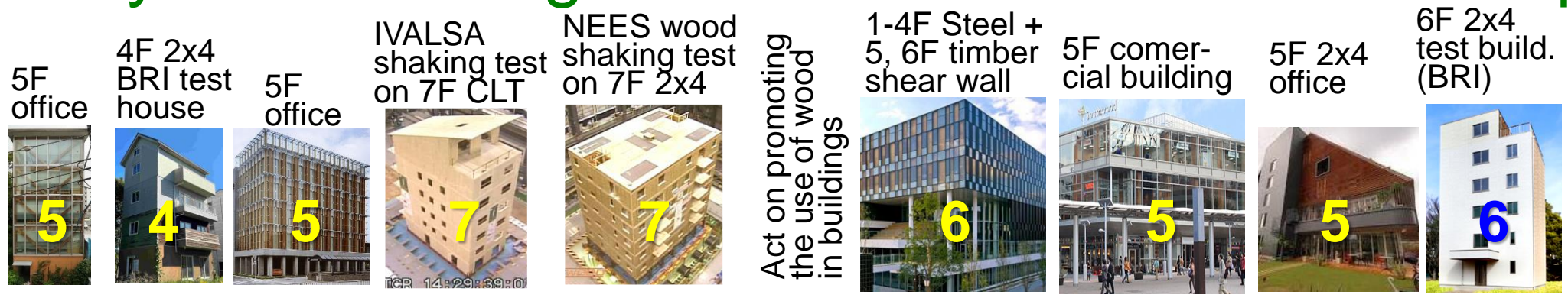
## Combination



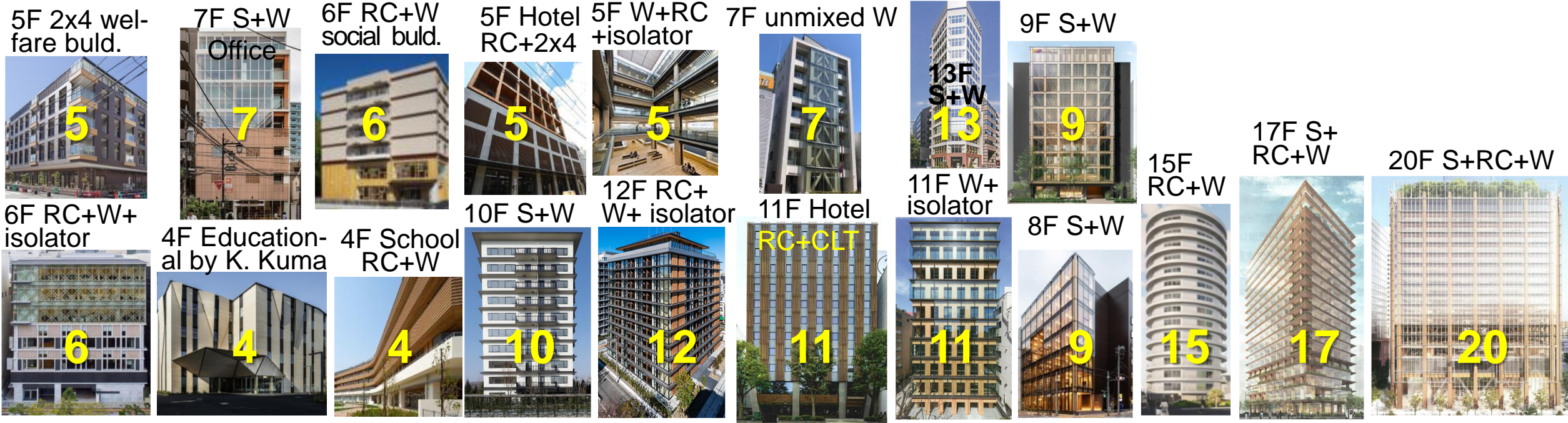


# Time history of mid- & high-rise timber construction in Japan

Height limitation of timber building was abolished.  
Self-charring-stop system was developed.



2000 2001 2005 2006 2008 2009 2010 2011 2013 2015 2016



2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2028 17

# Conclusion

- Mid- and high-rise timber construction in Japan is gradually increasing thanks to “Act on promoting the use of wood in buildings etc.”.
- Most of such buildings are constructed by a hybrid structure with wood and steel or RC due to the severe seismic and fire safety requirements. The building constructed entirely with wood-based materials as the main structural members is rare.
- Within the hybrid structures, wood-based materials are often used as the post and beam components. Glulam is much used.
- Seismic isolation systems are adopted in 11 buildings accounting for 1/5 of data extracted to study mid- and high-rise timber construction.

# Thank you for your attention!

## Danke für Ihre Aufmerksamkeit!

Special thanks to the Japan Federation of  
Construction Contractors (Nikkenren)

