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Demolition of Skyscrapers in Japan

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1. Introduction

In Japan, there are currently more than 700 skyscrapers with a height of 100m (328 ft) or more. The function and performance of the skyscrapers that were at the forefront a couple decades ago at the beginning of construction were obsolete after 30-40 years. In recent years, it has been discovered that long-period ground motion during an earthquake is a problem in high-rise buildings. There is a limit to the reinforcement and renewal, and it is expected that reconstruction of super high-rise buildings will increase in the future.

In 2012-2013, the new building of Akasaka Prince Hotel in Tokyo (39 floors above ground, 1 floor of penthouse, 2 floors of basement, 138.9m (456ft) in height) was demolished. In Japan, as well as from the international community, the general public were intrigued and the news was widely featured on TV and newspapers.

Demolition of a skyscraper that exceeds 100m (328 ft) in height leads to unresolved issues in the conventional demolition method that needs to be addressed. Skyscrapers are mostly located in urban areas, and there are many restrictions on demolition work compared to suburban and rural lands. There is a wide variety of issues that must be resolved: the wind in the sky being several times higher than that on the ground, the work of installing and removing temporary scaffolds, curing materials being a dangerous task at high places, dust being scattered over a wide area, the risk of dismantling members getting injured increasing, noise complaints and the propagation of vibration.

The five major general contracting companies in Japan have been paving the way in proposing the demolition skyscrapers through various technological developments.

The outline of each company will be introduced based on the materials released by the Japan Construction Federation and the information published on the website regarding the demolition of skyscrapers.

2. Kajima Corporation "Kajima Cut and Down Method" : Fig.1

Jacks installed at each pillar position in the lower floor support the entire building and demolishes the lower floor. For each column, the jack is promptly operated to support the load on the upper floor for each demolished layer, and when the demolishing of the same layer of the entire building is completed, the entire building is brought down with all jacks. This is a method of repeating demolition work by repeating this procedure.

With this method, noise and dust scattering can be suppressed compared to the conventional demolition methods. In addition, because constant work is always repeated near the ground, it is not necessary to refill environmental measures equipment and construction equipment. Also, the factors affecting the surrounding environment can be ensured at a fixed place and can be addressed steadily. Effective measures are taken to improve safety by reducing work in high places. The jacks installed on the lower floor will support the entire load of the upper floors, but to prevent earthquakes, a reinforced concrete core wall is installed before dismantling and seismic resistance is secured by the seismic mechanism using load transfer beams. This procedure was first applied in 2008 in the demolition work of the former Kajima Corporation

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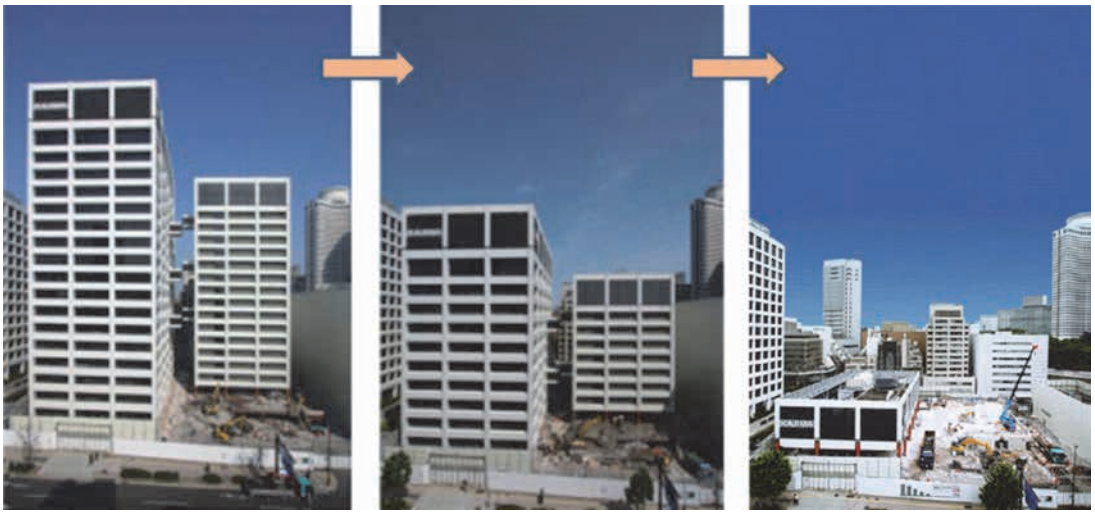

Fig. 1 Practical Use of Kajima Cut and Down Method (2008)

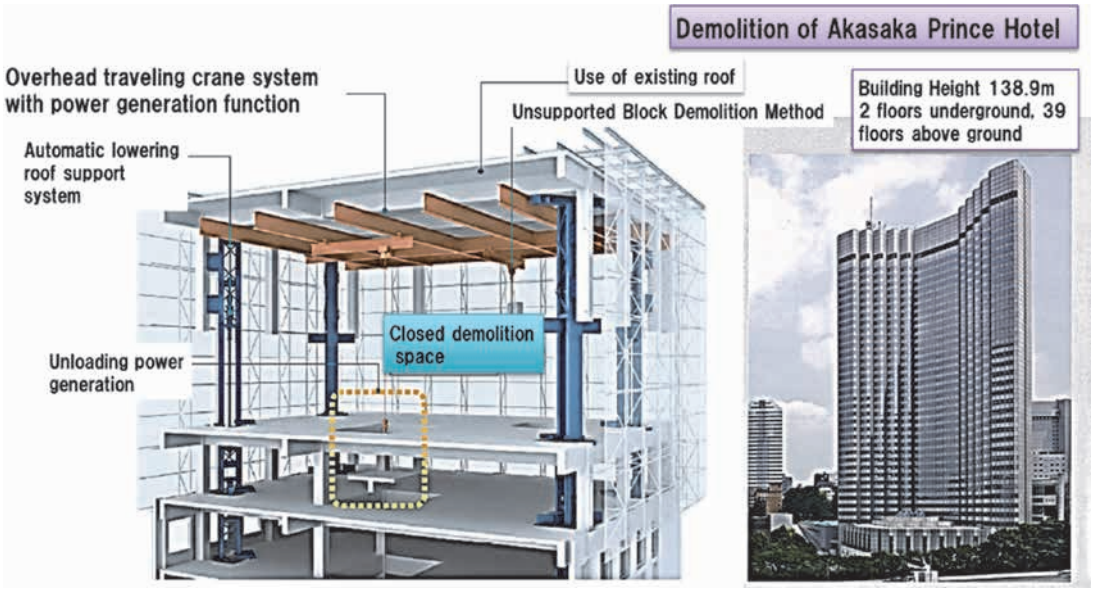

Fig. 2 Taisei Tecolep System

head office building (Steel structure).

3. Taisei Corporation "Taisei Tecolep System" : Fig.2

First, we will create a closed space that can be dismantled by effectively utilizing the structure on the top floor without breaking it. Then, a temporary pillar with a built-in jack is installed, and the dismantling floor is automatically lowered by the jack for each floor. By making the demolishing space a closed space, improvements can be made in terms of scattering/ falling parts, scattering of dust, noise, and vibration.

A slide type overhead crane for horizontal transportation is installed on the top-floor frame, and the telpher for vertical transportation is installed on the floor opening, and the disassembled members are unloaded by the crane. In addition, the free fall energy of the dismantling material that occurs during unloading is used to generate electricity to achieve a thorough energy reduction. This method was first applied at the Otemachi Financial Center (Steel structure) in Tokyo in 2011, and subsequently applied at the Akasaka Prince Hotel New Building (Steel structure) in Tokyo in 2012, which became a sensation in Japan as a demolished skyscraper. It has also been announced that the Taisei Ecological Reproduction System, known as "Tecolep-Light system" in Japan is applicable to the super high-rise buildings made by reinforced concrete. This "Tecolep-Light system" was applied in 2019.

4. Shimizu Corporation "Shimizu Reverse Construction Method" : Fig.3

This method was originally named as "the block

dismantling method", and the building was demolished from the upper part of the building to ground by using the tower crane, which is comm only used in newer constructions to dismantle the concrete slab into blocks by cutting with a cutter. This is a system that suspends and sorts at a dedicated processing site.

By combining skillful existing technologies that are highly reliable and have a proven track record, and by repeatedly disassembling the work efficiently, this process is extremely simple and unnecessary temporary equipment can be omitted. There are almost no restrictions when applied, and has excellent versatility.

Here, we are working to further improve efficiency by developing an attachment that integrates all the functions required for cutting the pillars and beams.

In 2008, it was applied to an S structural building with 2 basements and 14 floors above ground (CFT columns from 2nd to 14th floors).

5. Obayashi Corporation "Obayashi Cube-Cut Demolition Method" : Fig.4

Without crushing the structural members of floors, beams, and pillars, they are cut and lowered to the ground with a tower crane, sorted and carried forward on the ground to improve the efficiency of crane work and to implement shorter construction periods. At the same time, the cutting procedures of the structural frame and the measures that prevents

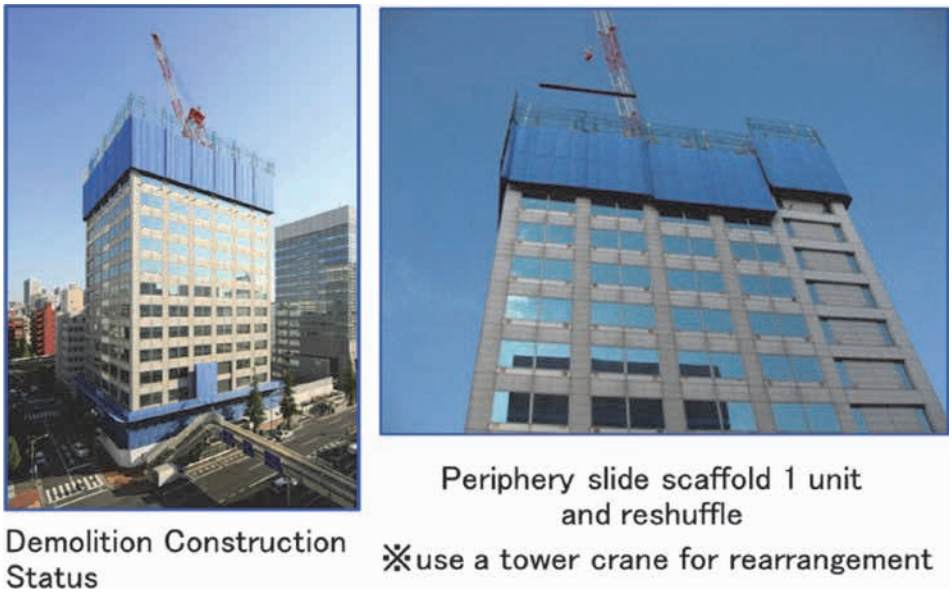

Fig. 3 Shimizu Reverse Construction Method

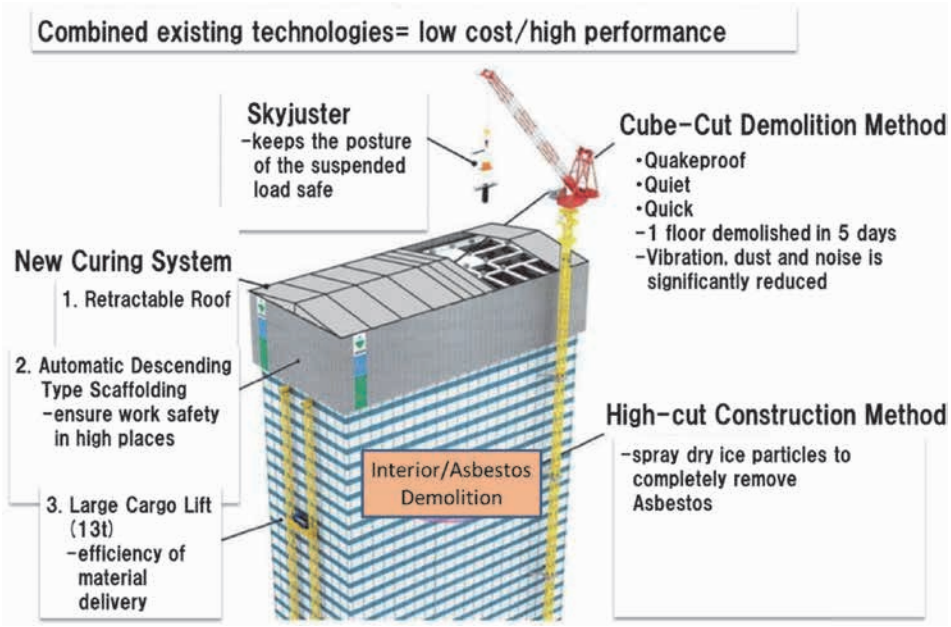

Fig. 4 Obayashi Cube-Cut Demolition Method

collapsing ensures the safety of the cut parts against earthquakes during demolition work.

6. Takenaka Corporation “Takenaka Hat Down Method” : Fig.5

This is a construction method in which a mobile demolition factory “hat” that covers the surrounding area is installed at the top of the building and the buildings are demolished sequentially while moving to the lower floor.

Inside the hat, demolishing equipment including an overhead crane is installed integrally, and it descends without a gap while wrapping the building frame to be demolished. All demolishing materials are lowered through the inside of the building. Therefore, it is safer and more environmentally friendly compared to the conventional method.

Since the cutter and wire saw are used to cut into blocks in the hat, diffusion of dust and noise can also be reduced. The demolished block is taken down from inside the building by an overhead crane, so there is no risk of parts falling down to the surroundings, which is effective for construction in urban centers.

In 2012, this method applied to the demolition of former hotel plaza in Osaka (1st-4th floor SRC construction, 5th-23rd floor S construction, RC construction underground, height 88m (289 ft)). It is also applicable when the high-rise part is made of RC.

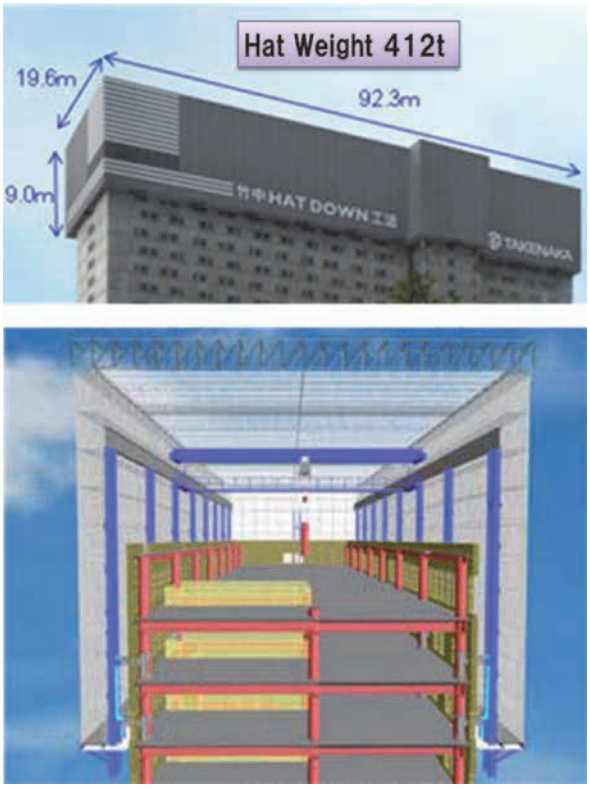

Fig. 5 Takenaka Hat Down Method

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Disclosure

This paper is an extended version of published without examination in Japanese[1)]

References

1) Noboru YUASA: Demolition of Skyscrapers in japan, Summary of research reports related to demolition work, Japan Demolition Contractors Association, PP.17-18, 2020.8

日本における超高層ビルの解体

湯浅　昇

概　　要

日本では，現在高さ 100 m以上の超高層ビルが 700 棟以上ある。竣工当初は時代の最先端だった超高層ビルも 30～40 年も過ぎれば機能・性能は陳腐化し，近年，大地震時の長周期地震動が高層ビルでは問題となることがわかってきた。補強・リニューアルには限界があり，今後，超高層建物の建替が増加してくると予想されている。

2012～2013 年，東京の赤坂プリンスホテル新館（地上 39 階・塔屋 1 階・地下 2 階，高さ 138.9 m）が解体され，日本では，テレビや新聞で大きく取り上げられ，広く一般市民や国際社会の興味を引くことになった。

高さ 100 mを超える超高層ビルの解体は，従来の解体工法では，解決しなければいけない問題が山積している。超高層ビルは，都市部に立地し，解体工事上の制約条件が多い。上空の風は地上の数倍にもなり，仮設足場や養生材の設骰・撤去が高所危険作業となることに加え，粉じんの広範囲への飛散，解体部材の飛来落下の危険性，騒音・振動の伝播などに，配慮しなければならなく，解決すべき課題多岐にわたる。

日本における 5 大ゼネコン各社は，超高層ビルの解体を，様々な技術開発を経て提案，先導的に手がけてきた。

本資料は，各社が，日本建設業連合会において，超高層ビルの解体に関して公開した資料，ホームページでの公開情報に基づき，鹿島建設「鹿島カットアンドダウン工法」，大成建設「テコレップシステム」，清水建設「シミズ・リバース・コンストラクション工法」，大林組「キューブカット工法」，竹中工務店「竹中ハットダウン工法」の概要を紹介したものである。

Biographical Sketches of the Author

Dr. Noboru Yuasa is a professor of College of Industrial Technology, Nihon University. He earned his B.Eng. in 1988 from Hokkaido University and M. Eng. in 1990 from Tokyo Institute of Technology.

After finishing master course in Tokyo Institute of Technology, he moved to Nihon University as a research associate. He promoted to a lecturer in 1998, an associate professor in 2003 and a professor in 2011. He received the degree of Dr. Eng. for "A Fundamental Study on the Quality of Surface Layer Concrete" in 1998 from Nihon University.

He has been studied "The surface layer concrete" in the point of view from moisture content and porosity as life work. And he received The Prize of AIJ 2019 (Research Theses Division) from Architectural Institute of Japan for "A SERIES OF STUDY ON SURFACE LAYER CONCRETE QUALITY" in 2019.

His current research topics include durability of concrete structures and finishing materials, non-destructive testing method, demolition of structures, earthquake resistance improvement for building of developing country and investigation of historical buildings.

He has been participated in several international research projects for Santuario di Vicoforte and L'Hangar per dirigibili di Augusta; 2002-03 and 2006-08, Sant'Agostino, San Silvestro e Torre Civica in L'Aquila; 2010-2014, Italy, Spain, Portugal; 2016-2021. And, he also participates in "Bhutan Project" by the JST/JICA SATREPS (Science and Technology Research Partnership for Sustainable Development).

During he was a lecturer of Nihon University, he was visiting researcher for one year at University of Dundee, England in 2011.

He is a chairman, secretary or research leader of a lot of committees in Architectural Institute of Japan, Japan Concrete Institute, Japan cement association, Japan Society for Finishing Technology and Japanese Society of Non-Destructive Inspection.