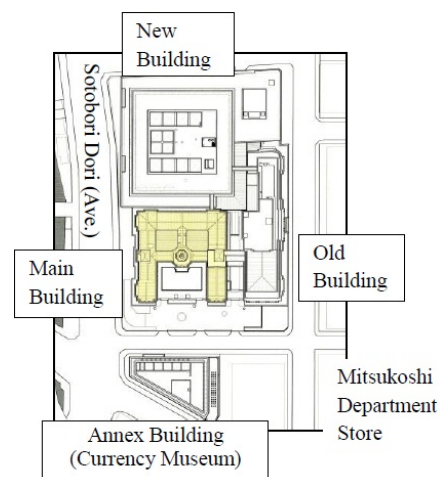


## Reinforcement Work on the Main Building of the Bank of Japan's Head Office

### 1. Introduction

The Main Building of the Bank of Japan's Head Office in Tokyo (three floors above ground and one basement floor; hereafter the Main Building) was designed by Dr. Kingo Tatsuno (1854-1919), a pioneer in the world of modern Japanese architecture, and in 2017 celebrates the 121st anniversary of its completion. As the first full-scale Western-style building by a Japanese architect of the Meiji period (1868-1912) and one of the most important buildings still in existence, it was designated an Important Cultural Property in 1974.

The Main Building has been stricken by a number of disasters in the past, most notably the Great Kanto Earthquake (1923). Despite suffering damage, it did not collapse and has undergone repair and refurbishment work over the years since then. However, estimates of the damage that would result from a possible Tokyo Inland Earthquake were revised upward in the wake of the Great East Japan Earthquake (2011). Accordingly, base isolation work began in October 2016 to enhance the Main Building's seismic safety and strengthen its business continuity capabilities as the nation's central bank.



### 2. Key Aspects of the Work

Base isolation work involves separating the foundations or lower part of a building from its upper part and inserting seismic isolation bearings -- made of laminated rubber, which consists of alternating layers of steel plates and rubber sheets -- into the space thus created.

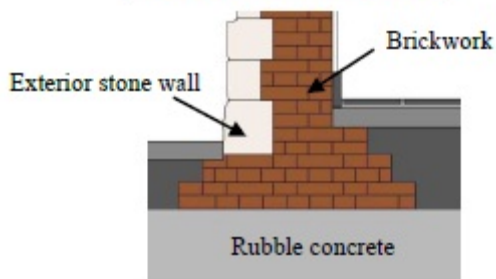
The seismic isolation bearings absorb the tremors of an earthquake, reducing the vibration of the building.

Base isolation work of this kind has been widely carried out of late, including on historic buildings. However, the base isolation work on the Main Building differs from the usual kind in a number of ingenious respects, relating to the nature of the work and the construction techniques used. These differences are outlined below.

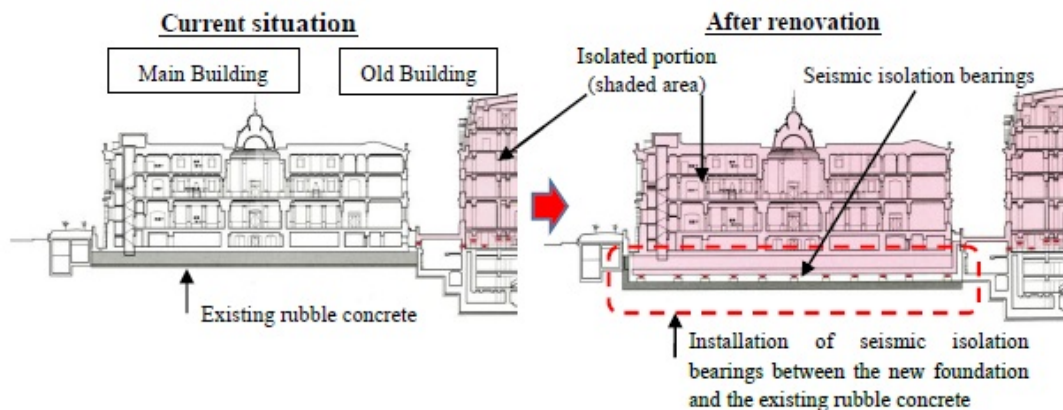
***Creative strategies in the nature of the work (1): Complete seismic isolation of the Main Building***

The Main Building consists of a brick foundation with stone walls: stone blocks for the outer walls and bricks for the inner walls are piled on top of each other, without the use of any steel reinforcement bars or steel frame. In addition, the building stands on a thick, strong concrete slab, a foundation called "rubble concrete."

**Illustration of the structure**



It was decided to take advantage of this feature in the reinforcement work, by keeping the rubble concrete, creating a layer of space around it, and laying a new foundation under that layer of space, with seismic isolation bearings installed in the space between the new foundation and the rubble concrete, seismically isolating the Main Building -- including the existing rubble concrete foundation -- completely from the new foundation.



This is called under-foundation base isolation (seismic isolation retrofit) and examples of its use in the base isolation of important cultural properties are beginning to be seen. However, according to the design contractor, this will be the first time that an historic building as big as the Main Building, with a total floor area in excess of 10,000 m<sup>2</sup>, has been completely seismically isolated along with its existing rubble concrete foundation.

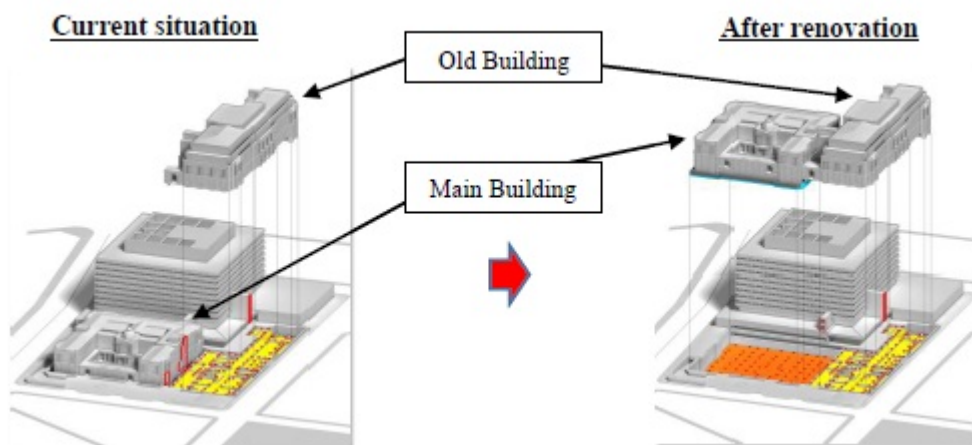
- ☞ More than 100 seismic isolation bearings will be installed under the Main Building, supporting its 75,000-ton weight (twice the total weight of all the steel frame used in Tokyo Skytree) from below.

***Creative strategies in the nature of the work (2): Complete seismic isolation in conjunction with the adjacent building***

The Main Building is located next to the Old Building (five floors above ground and four basement floors). Built to a design by Mr. Uheiji Nagano (1867-1937), a protégé of Dr. Kingo Tatsuno's, the Old Building was completed in 1938. The Old Building has a steel frame and steel reinforcement bars, structural elements that could be used for the installation of seismic isolation bearings. Accordingly, base isolation work was carried out on this building between 2006 and 2009, before the work on the Main Building.

As the seismic isolation bearings being installed under the Main Building are separate from those already installed under the Old Building, there is a risk that, in the event of a major earthquake, the two buildings could suffer damage from colliding with each other. Therefore, a strategy has been devised to avert this risk by firmly connecting the Main Building to the Old Building with complete seismic isolation of the adjacent Old Building and Main Building as a single unit.

Although examples of the base isolation of multiple new buildings connected together have begun to be seen in projects where this procedure has been planned in advance, the Main Building is the first example of seismic isolation of a building in conjunction with an existing seismically isolated building (the Old Building), according to the design contractor.

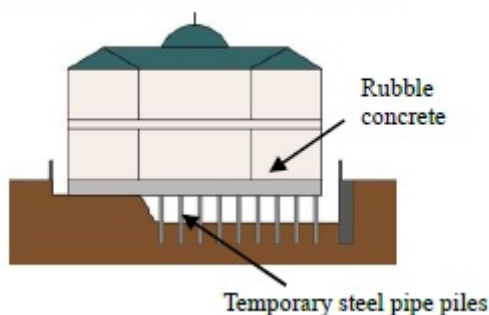


***Creative strategies in the construction techniques: Ensuring that both the buildings and the construction work are completely safe***

In carrying out this base isolation work, it is necessary to give full consideration to ensuring that this Important Cultural Property does not come to any harm. In addition, the Main Building is located at the heart of Nihonbashi, surrounded by roads full of vehicles and pedestrians, on a site filled with buildings. Accordingly, as well as ensuring safety while the work is being carried out, it is vital to fully ensure the earthquake resistance and safety of the building, in case of earthquakes or other natural disasters.

Various strategies are being adopted with this in mind in the reinforcement work. For example, the Main Building is, of course, being supported by a multitude -- as many as 500 in total -- of sturdy steel pipe piles. In addition, the excavation area has been subdivided and the order in which excavation is carried out has been carefully calculated.

**Illustration of the steel pipe piles**

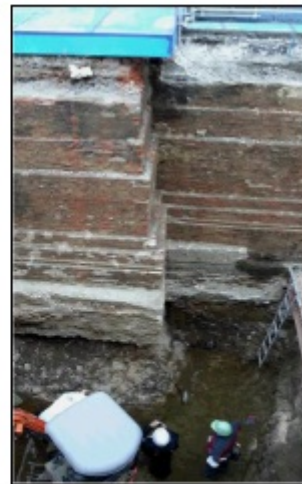


### 3. Schedule

The reinforcement work, which began in the autumn of 2016, began with the excavation of the area around the outside of the Main Building. This will be followed by excavation underneath the Main Building, the construction of the new foundation, and the installation of the seismic isolation bearings. Finally, the Main Building and the adjacent Old Building and New Building will be connected, with the whole project due to be completed in the summer of 2019.

2016	2017	2018	2019
	Construction		Completion

#### Excavation carried out in the front yard



### 4. Conclusion

The base isolation work will further increase the seismic safety of the Main Building and strengthen its business continuity capabilities as the nation's central bank. The Bank will continue to use the Main Building to carry out its business operations, including public relations activities in the form of guided in-house tours for the public. The Bank will preserve the building's value as an historic building (Important Cultural Property) long into the future.