01 What is the Liquefaction Map?

This Liquefaction Map was created by assessing the potential for liquefaction, taking into consideration the characteristics of the topography and ground of each area. The intensity of shaking, indicated on the Seismic Vulnerability Map, was also taken into consideration at the time.

The degree of risk for liquefaction indicated on this map is an estimated value based on ground information obtained thus far and does not indicate the degree of damage caused by liquefaction.

Furthermore, it does not reflect measures taken against liquefaction, such as ground improvements already in progress.

02 Purpose of Creation

This Liquefaction Map was created based on the assumption that it could be used, taking the opportunity of new construction and renovations, to give consideration to detailed ground studies and appropriate measures against liquefaction (improvement of soft ground, etc.) in areas that are thought to be at high risk of liquefaction.

In addition, it should be used to verify future maintenance plans for existing buildings with no piles and in areas where there is deemed to be a high risk of liquefaction.

03 Anticipated Earthquakes

Earthquake directly under the southern part of central Tokyo (M7.3)

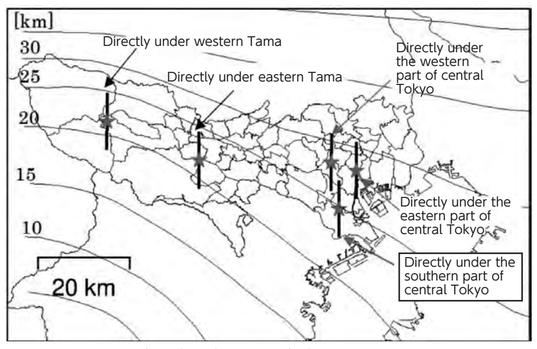


Figure 1: Location of earthquake source fault
Source: Anticipated damage to Tokyo from an earthquake directly under the Tokyo metropolitan area
The * symbol indicates the epicenter.

04 Process of Creating the Liquefaction Map

The map was created with the following main conditions for liquefaction predictions.

Target earthquake
Earthquake directly under the southern part of central Tokyo (M7.3)

Determining ground surface seismic motion
The seismic motion at the ground surface was determined from boring data collected from each of the approximately 8,700 boring points, owned by the City and from other related organizations, based on the Tokyo Metropolitan Government's "Anticipated damage to Tokyo from an earthquake directly under the Tokyo metropolitan area" (Tokyo Metropolitan Government, published May 25, 2022).

Determining physical property values
When calculating PL values, physical properties (soil size, soil density, etc.) must be determined for each soil layer (clay, sand, gravel, etc.). In order to establish the physical properties reflecting the area characteristics of the City, soil test results are used. These tests are implemented in approximately 200 locations within the City, based on the "Liquefaction Forecast for Tokyo Low-Lying Land" (Institute of Civic Engineering of the Tokyo Metropolitan Government, 1987). In establishing the physical properties, geomorphic elements such as plateaus, low-lying land, reclaimed land (sorted by when it was reclaimed), etc. were taken into consideration.

Calculation of PL value
Using the method in "Specifications for highway bridges," the liquefaction propensity for each stratum from 20 meters underground up to the surface is calculated, and the propensity for liquefaction in each spot is indicated as a PL value. As such, it is evaluated that there may be cases in which liquefaction does not occur on the surface but only in the ground.
*"Specifications for highway bridges" are the technical criteria prescribed by the Ministry of Land, Infrastructure, Transport, and Tourism in relation to bridges and elevated roads in Japan. This document is composed of five sections, and the earthquake-resistant design section provides regulations in order to ensure the safety of bridges at the time of earthquakes. The method for judging liquefaction is set forth within this document.

Map indication method
In order to understand the distribution of potential liquefaction in the area from the PL values calculated from each piece of boring data, areas were classified by liquefaction potential, by estimating lines connecting the ranges with the same PL value, as well as by combining boundary lines classifying topography. The results are displayed using a 50-meter mesh.

05 Liquefaction and the Topographical Formation of Minato City

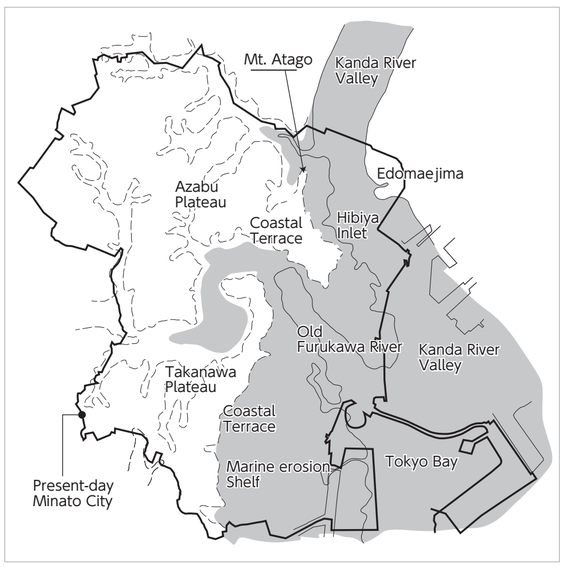


Figure 2: Old topography

In prehistoric times, the Kanto Plain was nothing but deep ocean, and there were only islands in the southern part of present-day Boso and Miura. In this deep ocean, fan-shaped land developed from sand which flowed from the ravines of the Tanzawa, Chichibu, Myogi, Haruna, Akagi, and Nasu mountain ranges.

New lands of sand then developed through marine transgression and regression, caused by the global climate fluctuating between warm and glacial periods. Numerous rivers carved out valleys, and by the time land was created, there were volcanic eruptions, including those from Mt. Fuji, and fallen ash loam covered the surface of the land.

In Minato City, the Hibiya Inlet and the old Furukawa River formed a V-shaped valley—the Kanda River Valley—during the glacial period, resulting in a steep mountainous form. In the following warm periods (Shimo-sueyoshi and Jomon periods), the two rivers were completely filled with accumulated clay and silt after a time when the sea level was a few meters higher than at present.

During these warm periods, the sea came inland, and coastal terraces formed on the eastern slope of Mt. Atago and the eastern side of the Takanawa Plateau. As the ocean waves washed against the bottom of these terraces, cliffs and shelves developed with marine erosion.

Meanwhile, a shallow sea spread across the Shibaura-konan area, and the Daiba area was a shoal across from the Kanda River Valley, the old Tokyo river tributary. In this shoal there were comparatively shallow and deep areas. Rough sand tended to accumulate in the shallow areas, while fine sand tended to accumulate in the deep areas.
Liquefaction is thus more likely in the areas where there are marine erosion shelves and shallow sea sediment.

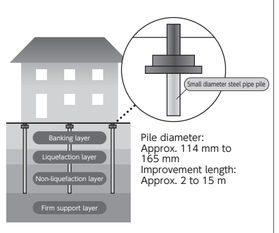
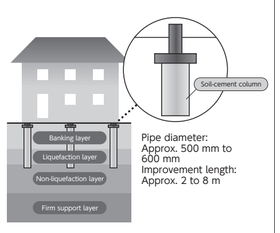
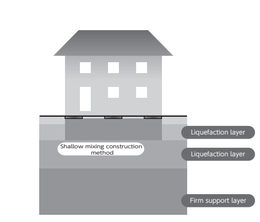
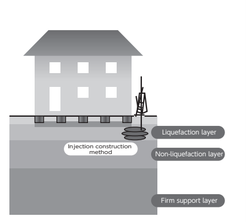
06 Reducing Damage Caused by Liquefaction

In order to reduce damage caused by liquefaction, firstly, it is critical to know what type of ground is present in the location where you live. It is also important to investigate what type of place that location was in the past. It is critical to implement measures against liquefaction on that basis.

Ground prone to liquefaction
Places prone to liquefaction are those where sand is lightly (loosely) compacted and the underground water is located high up, including places which were rivers, rice paddies and swamps in the past. Areas that have been reclaimed or cleared are more prone to liquefaction.

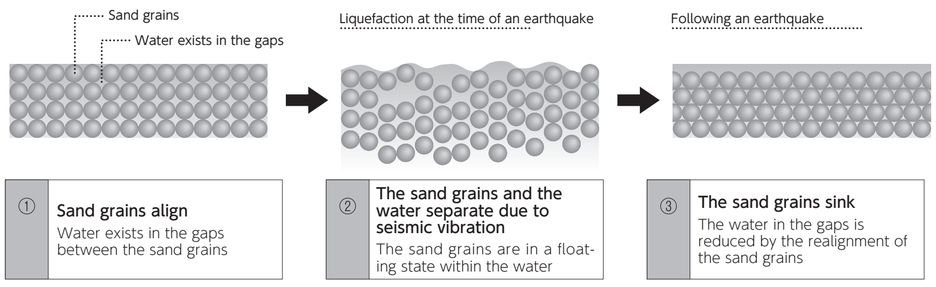
Ways to deal with liquefaction
The following are the principal methods that serve as effective measures against liquefaction for comparatively small buildings such as single-family homes, etc.
(1) Improve the ground to make liquefaction less likely
(2) Make the foundation a pile foundation
Suitable methods vary depending on the residential environment, etc., so please consult a specialist.

Measures against liquefaction (construction methods)

Method tailored to the foundation of the building	Methods that improve the ground		
Small diameter pile method	Deep soil mixing method	Shallow soil mixing method	Injection method
			
After ensuring the strength supporting the weight of the building with the base of the foundation, this method is used to install piles, such as steel tubes, by rotation or pressure insertion, to reduce total subsidence.	This is a method to improve the ground by installing column cross sections for improvement consisting of soil and solidification material beneath a base slab (underground beam) or foundation footing (inverted T-shaped foundation base material) in a pile-like form.	This is a method of improving the area directly under the foundation slab or foundation footing, including the area around the building, so it becomes a thin layer or slope by mixing cementitious solidifiers and raw soil.	This is a method to inject cement slurry (a liquid mixture of water and cement) and chemicals (liquid glass, etc.) into the ground.

07 Liquefaction Mechanism

Liquefaction is a phenomenon in which the ground temporarily becomes like liquid due to an earthquake, causing buildings on the ground to tilt or sink. If the sand layer, in a saturated condition due to underground water, maintained in a certain balance (Condition 1), is shaken by a strong earthquake, pressure is put on the water in the gaps between the sand, loosening the connections among the sand grains. The sand grains whose connections have come apart float in the water (Condition 2). The sand grains, in a liquid state, pour out onto the land surface from small cracks in the ground due to pressure caused by an earthquake. Following the earthquake, the pressure on the ground is reduced and the sedimentation and realignment of the sand grains occur (Condition 3). In this way, "liquefaction" is a phenomenon in which the ground becomes like a liquid.



Topography where the liquefaction phenomenon is likely to occur
Generally, liquefaction is liable to occur in low-lying areas and reclaimed land and liquefaction is less likely to occur on plateaus.

Primary damage caused by the liquefaction phenomenon
Sinking and tilting of buildings and structures
Surfacing of objects buried underground
Flooding and jetted sand

Figure: Mechanism and outline of the occurrence of liquefaction

*Prepared based on materials from the Japan Science and Technology Agency

08 Q&A Concerning Liquefaction

Q What should I do if my home is in an area with a high risk of liquefaction?

A Speak to an expert to make sure you understand the state of the strata and underground water, etc. Then, you can reduce damage by adding earthquake resistance to your building and/or improving the ground.

Q I'd like to know what this area was like in the past.

A Confirming the history of the land is one way to predict potential liquefaction. Comparing topography maps and older maps makes it possible to trace the history of land usage.
In the 2011 Tohoku Earthquake and Tsunami there were many reports of liquefaction damage in reclaimed land. Particular attention is necessary, as it is said that liquefaction damage is comparatively more likely to occur on land which was previously a river or rice paddy.
Topography maps can be purchased at bookstores or viewed at libraries.

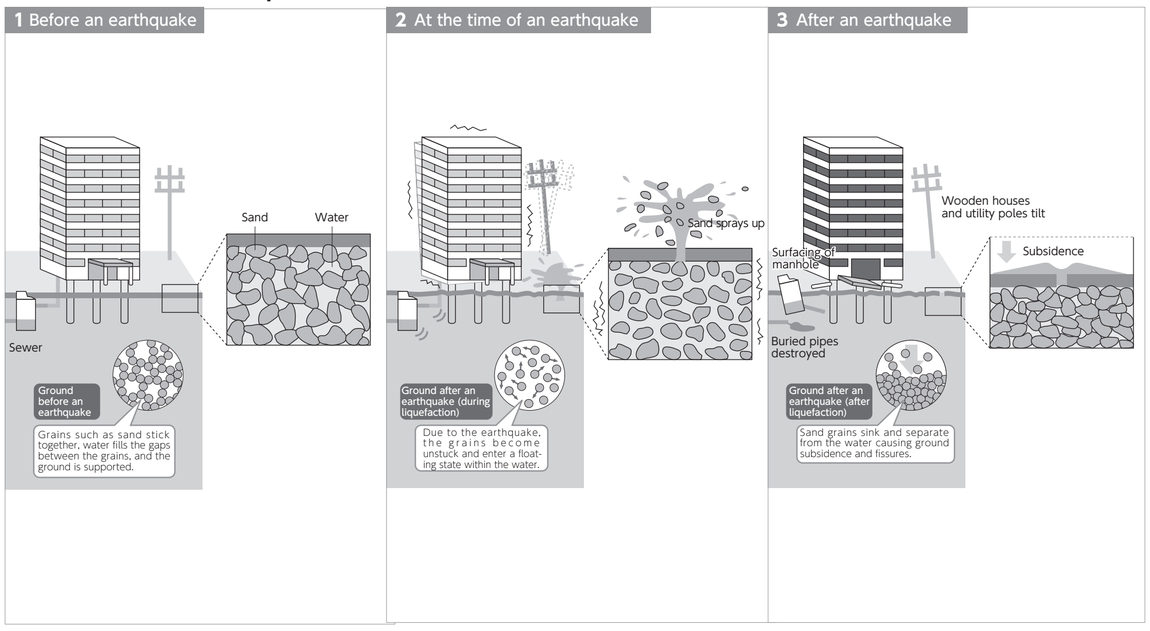
In addition, the following documents are available for inspection at the Structural Guidance Subsection, Construction Guidance Section.
•Neighborhood boring data

09 Precautions When Using the Liquefaction Map

If an area is marked as having a "high liquefaction potential" on the liquefaction map, it does not indicate that liquefaction will definitely occur, but these areas do have a comparatively high probability of liquefaction.

If you would like to make a more detailed study, please view neighborhood boring data and land feature maps, etc.

When the Ground Liquefies



The Minato City Disaster Prevention App is now Available

In light of the 2011 Tohoku Earthquake and Tsunami Minato City is currently offering the "Minato City Disaster Prevention App" free of charge to promote and raise awareness of disaster prevention among City residents, businesses, and others. Please use this app to check your disaster risk and prepare for disasters. (Only tablets or smartphones are supported.) In addition, each hazard map can be viewed in the app's "Minato City Disaster Prevention Map".

Main content

"Minato City Disaster Prevention Map," "Minato City Disaster Prevention Map by District," "Water Level and Rainfall Information (link)," "Safety Information," and "Minato City Disaster Prevention Information E-mail Service (link)."

"Disaster Emergency Message Dial (link)," "Railway Service Information (link)," "Buzzer Function (linked to device)"

"Light Function (linked to device)," "Various Disaster Prevention Pamphlets"

How to download the Minato City Disaster Prevention App

By scanning the QR code shown on the right, you will connect to the download screen. You can also find the app by searching for the keywords "Minato City Disaster Prevention App" on the app download service.

App Store (for iPhone)

Google Play (for Android)

Information on Disaster Prevention in Minato City

By scanning the QR code on the right, you will be redirected to that page.

Minato City Urban Planning Information Service

Minato City Disaster Prevention and Urban Development Guidelines