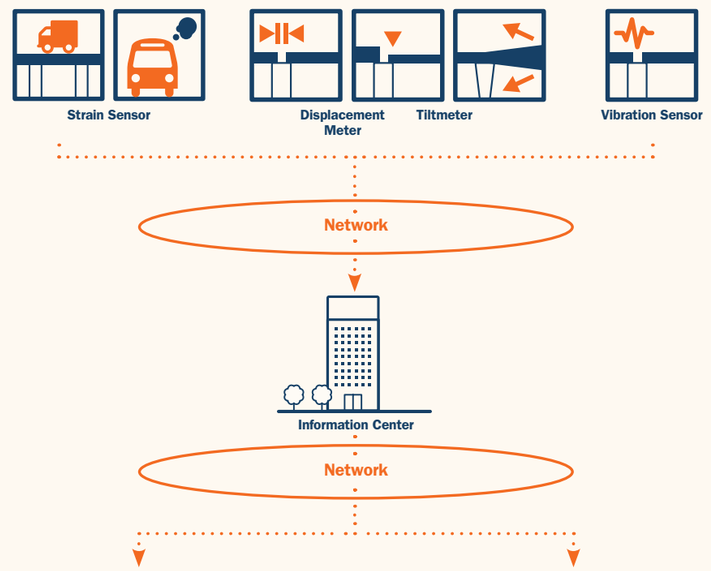
Dinosaur Bridge

Taking Care of Itself

Tokyo Gate Bridge at night



A diagram of a monitoring system

By Masahiro Doi

Two dinosaurs are facing each other. This unique sight over a main passageway in the Port of Tokyo is the Tokyo Gate Bridge, a.k.a. Dinosaur Bridge, which opened to traffic in 2012. With tens of thousands of cars crossing it each day, this bridge helps to relieve congestion in the area around the Port of Tokyo. Tourists also enjoy the fantastic daytime views of the port from the bridge's sidewalk, and at night the bridge is beautifully lit up and is popular with couples. It's one of Tokyo's new tourist destinations.

Designing this bridge presented a major challenge. Located at an important gateway to the port and very close to Tokyo International Airport, the bridge had to have enough clearance to accommodate large ships but also needed to limit its structural height to ensure flight route safety. This combination made for a tight squeeze. And since the bridge also serves as a disaster response route in the event of an earthquake, it had to be especially sturdy and durable.

Using a new methodology based on thorough FEM analysis,[1] the main bridge employs novel technologies, such as new high-quality steel members, panel point structure, and steel-plate deck structure. The bridge has a clearance of 54.6 meters and a structural height of 87.8 meters, making it as much as 40 meters lower than the nearby suspension bridge, the Rainbow Bridge. The Tokyo Gate Bridge is also lighter and cost less to build, and its new truss structure[2] is stronger and expected to last longer. This makes up the heads of the dinosaurs.

Not all of the new technologies employed are directly concerned with the structure or its construction. This bridge is also a leading example of the application of Japan's Internet of Things (IoT)[3] technology, and it is capable of monitoring its state of health. The main bridge structure is equipped with over 50 sensors, which are constantly gathering data on all sorts of conditions, such as the weather, elasticity, degree and direction of oscillation, and vehicle weight of traffic. The data is then transmitted to the management system at a rate of thousands of units per second.

Analysis of these data will allow immediate detection of any abnormalities in the bridge. Abnormalities arise mainly due to typhoons, earthquakes, and other natural disasters; aging as a result of temperature changes, salt damage, and other environmental factors; and wear and tear from the weight of heavy vehicles. If abnormalities can be detected from the data collected by the sensors, based on their type and degree, the information can be used to regulate traffic in real time, as well as to achieve more efficiency in routine maintenance work by predicting or identifying problems.

It is hoped that this practical Tokyo-based IoT technology will be used for many bridges all over Japan. It is also hoped that this technology will be exported to other countries to help address the issue of aging infrastructure. This technology has already been applied to the Can Tho Bridge in Vietnam, one of the longest bridges in Southeast Asia.

A day may come one century from now when the Tokyo Gate Bridge is lauded as a legacy of the dawn of Japan's IoT technology.

1. FEM (finite element method) is a leading method employed in structural analysis. In the design of the Tokyo Gate Bridge, detailed FEM analysis was conducted on each part of the bridge structure, including repeated computer simulations. Based on this, verification of fatigue durability and other properties were conducted on large-scale installations.

2. A "truss structure" is created by combining multiple triangular units formed by steel members and other elements. The many parts involved often result in an unsophisticated shape, but a new simple structure was achieved in the Tokyo Gate Bridge by using new methods and technologies, while also giving consideration to the surrounding landscape.

3. IoT (Internet of Things) is the connection of all kinds of things via the Internet.

Masahiro Doi is a writer specializing in IT web media for more than 20 years.