KNOW YOUR BRIDGE INSIDE OUT

Next-generation SHM & WIM technology, for safer, longer-lasting bridges

UNIQUE. WORLDWIDE.

Penang Second Bridge, Malaysia - instrumented with Kistler measurement technology

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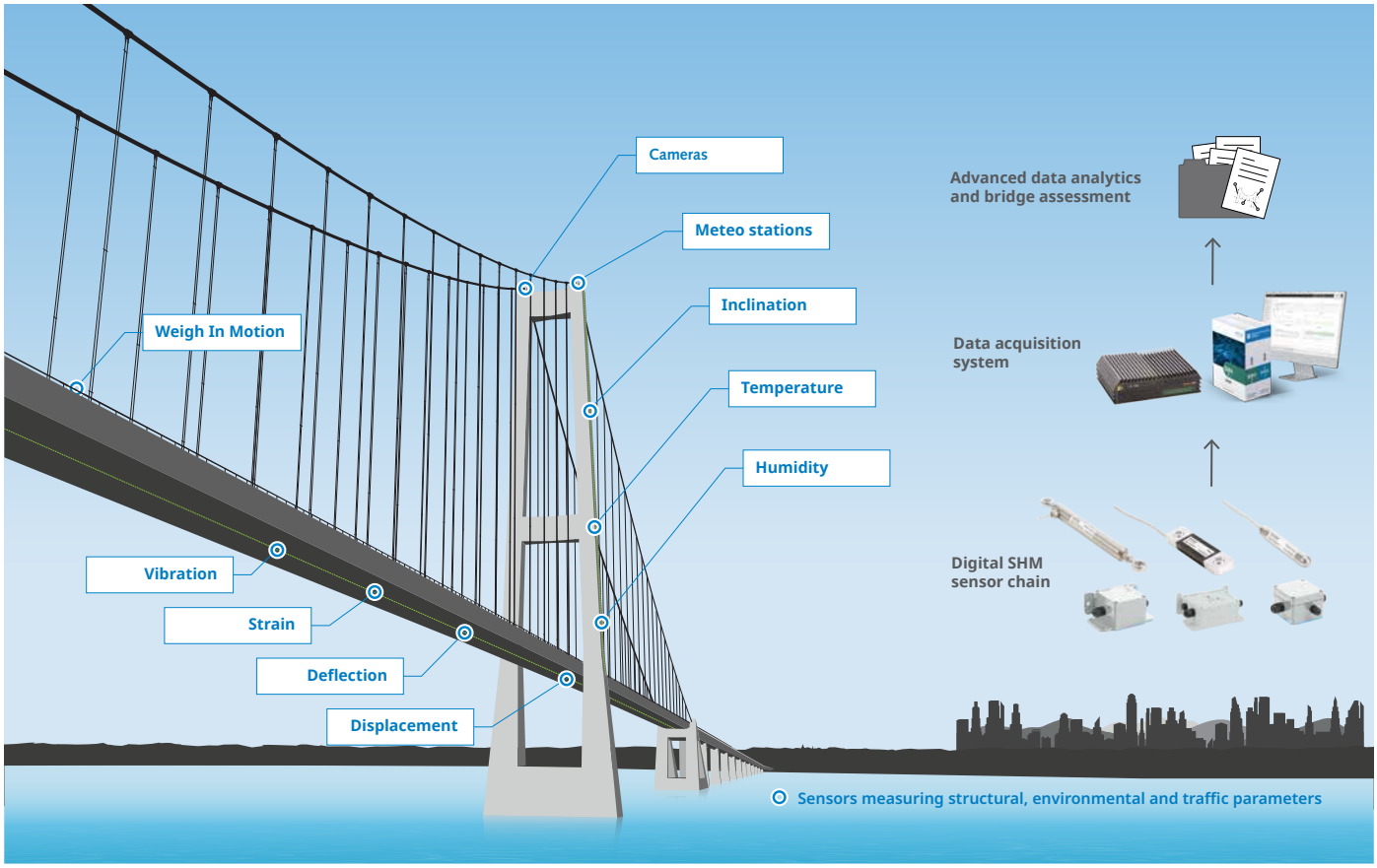


Complete Bridge Structural Health Monitoring – combined with vehicle weight monitoring and enforcement

Protecting sensitive infrastructure with Structural Health Monitoring (SHM)

Bridges are backbones of the economy in every country in the world. These key elements of the traffic infrastructure usually consist of steel, cast iron and prestressed concrete – and nowadays, many of them are aging. It is very difficult to determine a bridge's stability merely by inspecting the structure from the outside. But thanks to Structural Health Monitoring (SHM), operators now have solutions to identify degradations of a bridge's structural integrity at an early stage – so they can take proactive and efficient steps to address these critical issues.

A bridge's structural integrity degrades naturally over time due to fatigue, cracking and corrosion. Also, increased traffic loads and harsher weather conditions place additional burdens on bridge structures. Critical structural deficiencies are present in an extremely high number of bridges built over 50 years ago as they approach (or even reach) the end of their service lives – but the same issues also affect many newer bridges that are not properly maintained. Drastic measures such as closing a bridge or imposing heavy limitations on traffic must be avoided at all costs. This is why maintaining bridges to extend their service lifetimes and ensure their safety is an overriding priority for all operators. There are limits to what regular inspections and assumption-based structural models can achieve – and this is precisely where sensor-based bridge monitoring (SHM) comes into play.

The SHM solution from Kistler for bridge monitoring addresses these challenges head-on. The measurement system captures key parameters (such as vibration, strain, displacement and many more) and delivers actionable insights and an objective view of how bridges behave under actual operating conditions. This enables infrastructure operators to detect damage at an early stage, to prioritize maintenance effectively, and extend service life.

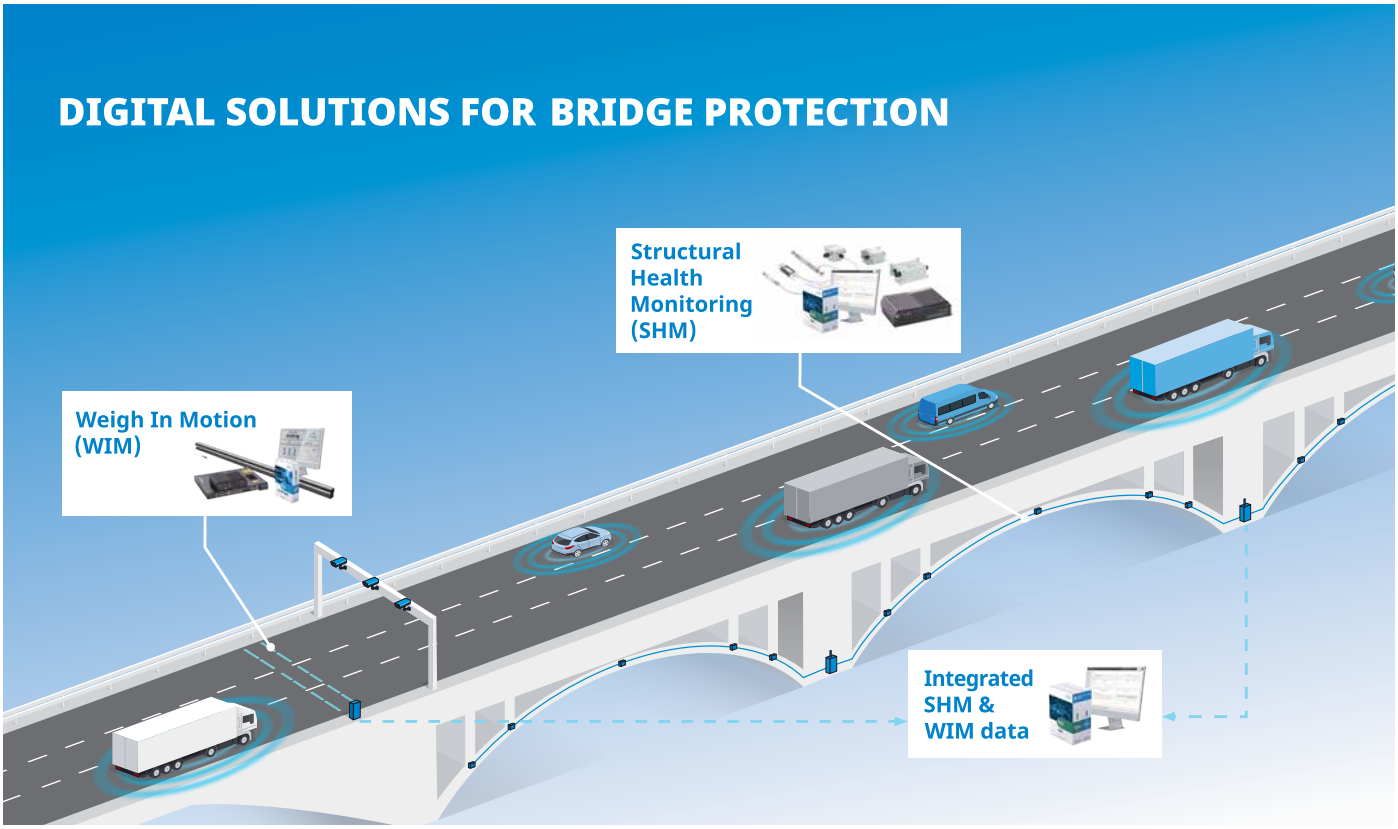
SHM & WIM – a unique system to protect bridges and extend their service life

The Kistler bridge monitoring system integrates advanced Structural Health Monitoring (SHM) and Weigh In Motion (WIM) digital technologies to efficiently monitor structural changes, detect damage, and capture traffic load data.

Traffic loads have a direct impact on bridge fatigue – so it follows that analysis of real traffic loading plays a critical part in assessing a bridge's fatigue and its remaining lifetime. When monitoring bridges and performing structural analysis, consistent information on real traffic loads and travel speeds is essential. Compliance with legal loading and speed limits is a key factor in ensuring traffic safety and the health of a bridge structure.

The SHM & WIM system from Kistler is a unique end-to-end system that natively combines Structural Health Monitoring (SHM) and Weigh In Motion (WIM) within one digital architecture – from sensors to data. Traffic actions and structural responses are recorded on a common time base and analyzed together.

The provided data from WIM will support long-term traffic loading analysis, allowing operators to replace probabilistic traffic models with site-specific load spectra for the bridge being monitored. Furthermore, operators can configure automatic alarms that notify them when the WIM system detects overloaded vehicles. WIM triggers can be configured in the system to directly correlate specific vehicle loads with the resulting structural impact, giving infrastructure operators real-time visibility into how traffic affects the bridge's structural health. A single dashboard collects all data from the SHM & WIM system to allow continuous visualization and optimal setting of alarms and triggers.



SHM & WIM systems from Kistler provide a synchronized dataset that captures both traffic loads and structural responses under real operating conditions. This allows operators to compare effective loads with bridge capacity and reliably assess performance and safety.

Digital SHM: the most advanced SHM system that combines the widest selection of fully digitized structural sensors.

Digital SHM – the most advanced bridge structural health monitoring system

The newest Digital SHM system from Kistler delivers ultra-high data accuracy and is designed for maximum durability. It enables rapid field deployment with automatic configuration and is the number-one choice when it comes to long-term monitoring of any bridge structure.

Built on a fully modular architecture, the system can be easily adapted and scaled to suit any type of bridge. The SHM system utilizes sensor clusters comprising both static and dynamic sensors. These fully digitalized sensors can be installed in various configurations such as daisy chain or star topologies enabling streamlined installation with minimal cabling effort.

A WIM system is installed upstream of the bridge to monitor traffic loads and enforce vehicle weight limits – at any speed and with highest precision.

Data from the SHM and WIM systems is streamed to the edge device (IPC) with the highest levels of precision and time synchronization. All sensor clusters are precisely synchronized (within 1 microsecond), and the data is collected by the edge device at maximum resolution and sampling rate. From there, relevant data sets – triggered by specific events – are transmitted via an open interface to the customer's upper-level system. An intuitive, cloud-based user interface is available for system configuration and sensor data visualization.

Advantages of the SHM & WIM digital architecture

- Combined data set of structural and traffic load measurements, offering maximum accuracy and resolution
- Simplified installation with minimal cabling (such as daisy chain or star topologies)
- Perfect time synchronization across all sensors
- Smart triggers for high-resolution data (time-based, event-based, and WIM-based): only the most relevant data is selected for further processing
- Robust, weatherproof design with full immunity to electromagnetic interference
- Open interface to upper-level systems

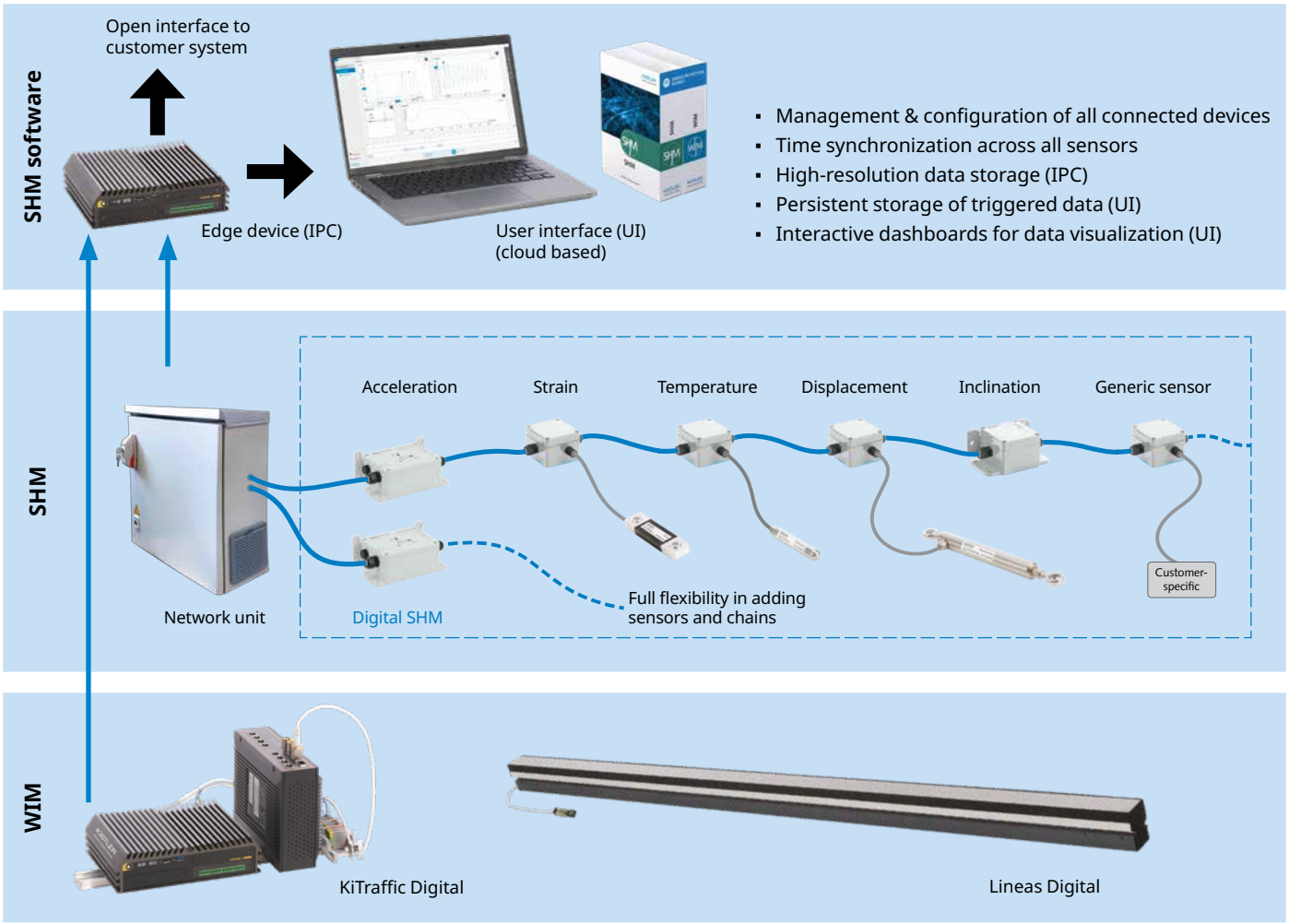
The digital SHM system
The SHM system continuously monitors vital structural parameters around the clock and detects changes over time. It offers a wide range of high-quality sensors to efficiently monitor any type of structure. If needed, the measurement chain can be extended with customer-specific sensors.

All sensors are fully digital and support installation in daisy chain and star topologies.

SHM sensors and measured data:
- Acceleration and vibration
- Strain
- Displacement
- Inclination
- Temperature
- Open interface (voltage/current) for customer-specific sensors

The WIM system
The WIM system automatically monitors traffic 24/7 and enables traffic load monitoring, overload detection, and enforcement of weight limits. It accurately measures vehicle weights at any speed and instantly generates a detailed vehicle data record. Overloaded vehicles will trigger synchronized collection of structural data, and the WIM data is seamlessly integrated into the SHM data.

Vehicle data captured by WIM:
- Vehicle weights (wheel loads, axle loads, gross vehicle weight)
- Vehicle classification, length, and axle spacing
- Wheel configuration (single or dual) and flat tire detection
- Vehicle speed
- Time and date of travel
- Traffic volume and vehicle spacing



Iconic bridges monitored and protected by SHM & WIM from Kistler

Brooklyn–Queens Expressway (BQE),
City of New York, USA

El Carrizo Bridge,
El Palmito, Mexico

Third Bosphorus Bridge,
Istanbul, Turkey

1915 Çanakkale Bridge,
Çanakkale, Turkey

Washington Bridge,
State of Rhode Island, USA

Robert F. Kennedy Bridge,
City of New York, USA

Penang Second Bridge,
Penang, Malaysia

Cebu–Cordova Link Expressway,
Province of Cebu, Philippines

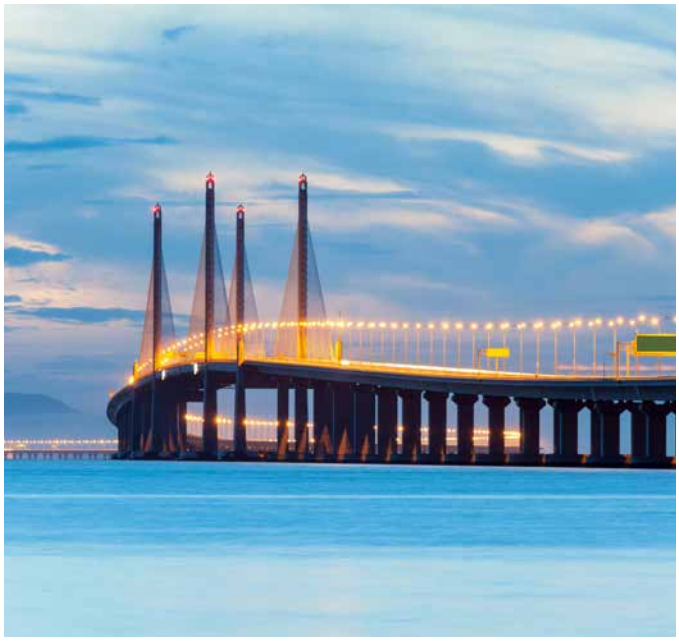
Sutong Yangtze River Bridge,
Jiangsu province, China

Jiangyin Yangtze River Bridge,
Jiangyin, China

Real time structural and traffic monitoring for the Washington Bridge

The Rhode Island Department of Transportation (RIDOT) has deployed an integrated Structural Health Monitoring (SHM) and Weigh-In-Motion (WIM) system on the Washington Bridge in the city of Providence to support the safe operation of the south span during reconstruction of the north span. Following the closure of the north span in December 2023, all traffic was rerouted to the south span; therefore, continuous monitoring became essential to manage increased traffic loads while observing structural changes. The project uses Kistler's combined SHM and WIM technologies to capture real time data on bridge behavior, environmental conditions, and commercial vehicle weights. More than 200 structural sensors and digital WIM sensors embedded in the roadway enable RIDOT to detect abnormal structural responses, monitor thermal and dynamic effects, and identify overweight vehicles – averaging more than 50 per day. The system provides a comprehensive data foundation for maintenance decisions and will be expanded to the reconstructed north span, creating one of the world's largest SHM & WIM sites.

Bridge protection: Weigh In Motion enables 24/7 heavy traffic enforcement on the Penang Second Bridge



The Second Penang Bridge in Malaysia, a 24 kilometer sea crossing structure connecting Penang Island with the mainland, has become a critical transport corridor for one of Southeast Asia's most dynamic industrial regions. To support safer operations and protect the bridge from increasing heavy duty traffic, Weigh In Motion (WIM) systems from Kistler have been in operation since 2022 as part of a national monitoring and enforcement initiative. The system captures axle loads, gross vehicle weight, speed, and vehicle classification in real time, enabling enforcement of overloaded trucks without disrupting traffic flow. Lineas quartz sensors embedded in the pavement ensure accuracy and stability even under Penang's challenging tropical climate and corrosive marine environment. Data from the WIM site contributes to more effective traffic analysis, congestion forecasting, and maintenance planning. With continuous monitoring and reliable enforcement, the bridge operator reports fewer overloaded vehicles, improved road safety, and enhanced long term protection of this major infrastructure asset.

Would you like to learn more about our our SHM application? Explore now:

www.kistler.com/bridges

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