

Trend Article ASC Bridges

Why bridges need our attention

Weigh In Motion (WIM) and Structural Health Monitoring (SHM) protect sensitive infrastructure

Bridges all over the world can be efficiently monitored with Weigh In Motion (WIM) and Structural Health Monitoring (SHM), extending their service life and, in a worst-case scenario, preventing their collapse. The Kistler Group installs solutions of this kind worldwide, continuously developing its sensors and measurement technology further to contribute to the safety and longevity of bridges in the most efficient manner possible.

Bridges connect people. They promote mobility and enable a rapid exchange of goods and services. As part of vibrant arterial routes crossing rivers, valleys, buildings or estuaries, they stimulate enterprise and prosperity. Since it became possible to calculate bridges with increasing accuracy in the 19th century and new materials also became available – beginning with cast iron and steel, then reinforced and prestressed concretes – the number of bridges constructed increased all over the world. It is evident today that many of these have aged considerably. This is partially due to their abundance, with five-digit numbers existing in many industrialized countries. It is also due to the fact that, during the construction boom following the Second World War, it was impossible to anticipate the enormity of traffic volumes in the 21st century, volumes that continue to grow in many places.

These conditions often lead to the collapse of bridges, despite regular inspections and repairs. The Fern Hollow Bridge in Pittsburgh (USA), an approximately 135-meter-long three-span steel bridge over a forest ravine, collapsed on 28 January 2022. Fortunately, no fatalities occurred, although several vehicles, including a bus, were involved in the collapse. How can accidents of this nature be avoided, and which technologies are available to protect bridges more effectively?

Ensuring observance of weight limits with Weigh In Motion

Restrictions relating to velocity and vehicle weight are frequently encountered on bridges, particularly where heavy traffic is involved. The strain experienced by the structure increases exponentially as vehicles become heavier, with trucks and heavy commercial vehicles in particular causing excessive stress to roads and bridges. However, speed and weight restrictions unfortunately only have a limited effect as they are frequently not observed. A Weigh In Motion system is particularly effective in ensuring compliance with regulations. In addition to measuring the overall weight of the vehicle, sensors integrated directly in the road surface also determine the real

extent of significant axle loads. This is achieved in moving traffic at normal speeds (heavy traffic up to 120 km/h, vans up to 140 km/h) and in several lanes. Three specific advantages that contribute to effective bridge protection are derived from this:

1. The acquisition of weight-related vehicle data provides an accurate basis for calculating the actual load on the bridge and the remaining service life (instead of estimates).
2. Overloaded vehicles that exceed the permissible overall weight can be prevented from crossing the bridge (so-called preselection). The collection of fees is also possible, depending on domestic legislation in the particular country.
3. The WIM system can be combined with further sensors and cameras to, for example, detect speed, the condition of tires and vehicle dimensions, thus contributing to increased road safety on the bridge.

Weigh In Motion for efficient international bridge protection

KiTrafic series Weigh In Motion systems from Kistler are deployed for this reason on many bridges around the world, collecting traffic data and ensuring applicable rules are observed. A WIM system from Kistler has been monitoring the spectacular El Carrizo bridge in Mexico since the summer of 2018. Overloaded vehicles are preselected and prevented from crossing the structure that, at 226 meters, is the second-highest bridge in North America.

Older and smaller bridges can also be protected with WIM systems. A solution of this kind was used in Austria for a road traffic bridge spanning a very busy long-distance line operated by Austrian Federal Railways (ÖBB). Due to the presence of a sawmill nearby, the bridge had already been damaged by heavy timber transports. KiTrafic Statistics helped to reliably detect trucks that were frequently massively overloaded and, in cooperation with the authorities, these were ordered to pay a fee. Overloading of the bridge reduced correspondingly within a short period of time.

Real-time condition monitoring thanks to Structural Health Monitoring

Despite the usefulness of WIM systems in providing modern bridge protection, they cannot provide any information on the actual condition of the structure. Further technologies frequently associated with condition monitoring and structural health monitoring (SHM) therefore play a significant role. This involves the installation of sensors at key positions on the bridge to, for example, record vibrations or changes in the construction material. The quality of data is decisive for reliable condition monitoring. The entire measuring chain from sensor to software must be examined in this respect to ensure that what is seen on the monitor is as accurate a representation as possible of what is currently happening on and, indeed, "in" the bridge. With regard to real-time monitoring,

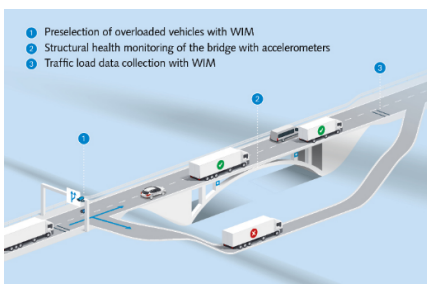
particular attention must be paid to the achievement of high-quality signal transmission and data acquisition.

In addition to strain sensors and accelerometers as individual components, the Kistler Group also provides complete solutions from sensor to cloud. K-Beam accelerometers from Kistler have been installed in the piers of the Great Belt Bridge in Denmark, a structure which has spanned the Great Belt strait in the Baltic Sea since 1998. These compact sensors continually record changes in natural frequency in real time that could indicate a possible deterioration in the condition of the bridge. Turnkey systems consisting of sensor technology, the KiDAQ data acquisition system and a customized software dashboard are also increasingly employed. Solutions of this kind enable authorities and bridge owners to monitor the condition of these structures continuously and reliably, and they provide support when planning everything from maintenance management to new constructions.

Image material (please name the Kistler Group as picture source)



Structural health monitoring with Kistler: the Great Belt Bridge in Denmark is monitored continuously for structural changes with the aid of K-Beam accelerometers.



Bridge protection with Kistler: Weigh In Motion for traffic data acquisition and preselection of overloaded vehicles, and structural health monitoring of the structural condition.



Weigh In Motion solutions from Kistler, consisting of sensor technology, data acquisition, a user interface and software, protect bridges against overloading and provide accurate heavy traffic data.



Installation of Lineas sensors from Kistler for Weigh In Motion (WIM): dynamic axle load measurement in moving traffic enables efficient bridge protection.

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About the Kistler Group

Kistler is the global market leader for dynamic pressure, force, torque and acceleration measurement technology. Cutting-edge technologies provide the basis for Kistler's modular solutions. Customers in industry and scientific research benefit from Kistler's experience as a development partner, enabling them to optimize their products and processes so as to secure sustainable competitive edge. Unique sensor technology from this owner-managed Swiss corporation helps to shape future innovations not only in automotive development and industrial automation but also in many newly emerging sectors. Drawing on our extensive application expertise, and always with an absolute commitment to quality, Kistler plays a key part in the ongoing development of the latest megatrends. The focus is on issues such as electrified drive technology, autonomous driving, emission reduction and Industry 4.0. Some 2,000 employees at more than 60 facilities across the globe are dedicated to the development of new solutions, and they offer application-specific services at the local level. Ever since it was founded in 1959, the Kistler Group has grown hand-in-hand with its customers and posted sales of CHF 434 million in 2022. About 8% of this figure is reinvested in research and technology – with the aim of delivering better results for every customer.