Introduction to Advanced Structural Health Monitoring Systems

With the discovery and development of new materials and technologies in recent decades, the field of engineering and construction has become one ambitious, demanding and full of challenges. The rise of these new technologies have allowed to the engineers exceed those limits faced by the engineers of the past, allowing them to build higher buildings, longest bridges and essential structures with a high level of complexity and environmental control. This high level of complexity and demand has increased the requirement for advanced monitoring systems that provide to the owners immediately information, accurate and reliable to help them save costs related to maintenance, environmental safe and information to prevent failure or structural damage.

Why Monitoring

- Validate design assumptions.
- Measures and improve performance of its structures, industrial equipment and resources.
- Assessing the behavior of the structure and possible time-dependent deterioration.
- Verifying integrity and structural strength.
- Enhance safety program reducing risk of major accidents for unknown reason providing an early warning identifying looming problems.
- Reduce the risks of instability of excavation works.
- Reduces maintenance cost and improve maintenance program.
- Reveal unknown changes.
- Inform stakeholders.
- Enhance Quality Control and process programs.
- Satisfy regulation requirements.
- Optimization of more expensive construction materials.
- Optimization of efficiency.
- Anticipate the effects of the announced climatic change
- Detection of random events such as cavities, breaches, leaks, settlements and Seismic zones.
- Assess the ageing status and follow-up of contemporary and historic structures.
- Promotes the development of new materials and techniques constructive.
- Reduce litigation.

Monitoring System Architecture

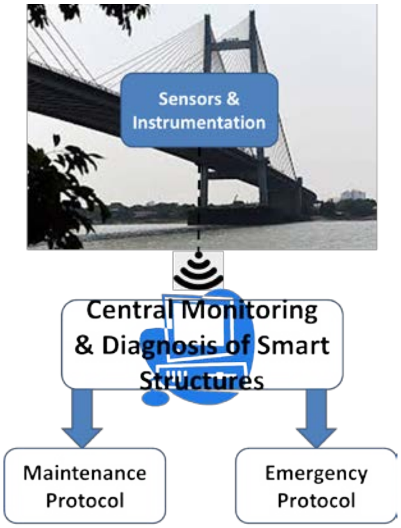
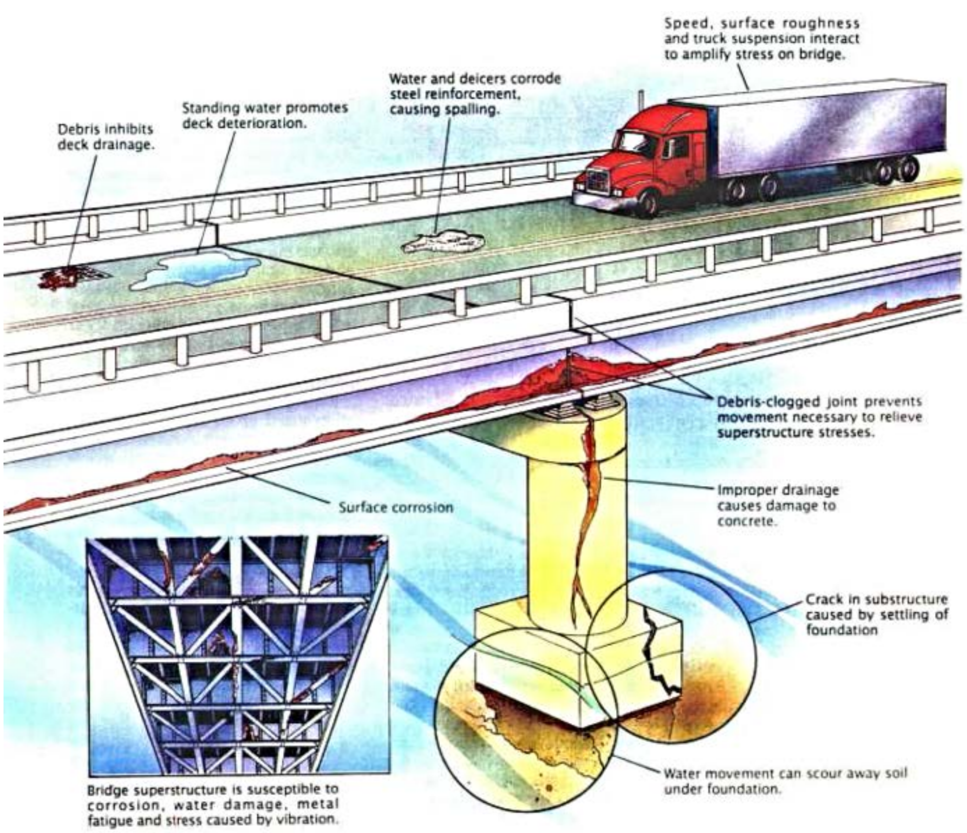


Figure 1 SHMS Monitoring System

Requirement of Monitoring of Highway Structures

Know bridge behavior and effects under construction loads, service and extreme loads. Reduce operational and maintenance cost.

Common causes of deterioration and failure of bridges are:



The use of smart structural health monitoring systems in the highway bridges will help to have best & better understanding of the structure behavior, early detection and location of failures verification of integrity and structural strength, reduction in costs and inspection periods, improved maintenance programs, increase security and reliability.

Below some of the sensors used to monitor the bridges' behavior and performance:

TYPE	FUNCTIONS	APPLICATIONS
Strain Gages Sensors	Measurement of strains, deformations and stresses	Strains and stresses steel girders, cables, gusset plates, reinforced concrete, piles, pre- & post-tension elements
Temperature Sensors	Measurement of absolute temperature on structure's surface and relative temperature for compensation of strain measurements	Concrete cure, structural elements and weather station
Displacement Sensors	Measurement of displacement between two gauge points	Construction joints, crack/fissure growth and structural members
Accelerometers	Measurement of accelerations from DC to low frequencies and modal analysis	Piers, abutments, decks, towers and cables
Inclinometers	Measurement of angular variation, differential settlements and slope displacements	Piers, abutments, footings, wing walls, towers, approach embankments and excavations
Piezometers	Measurement of drainage, leakage, water level, water pressure and pore pressure	Pipes, excavations, embankments, rivers and banks
Pressure & Load Cells	Measurement of loads and pressures	Foundation, embankment and structural elements
AE Acoustic Emission	Detects crack growth, friction and corrosion	Steel elements and welds

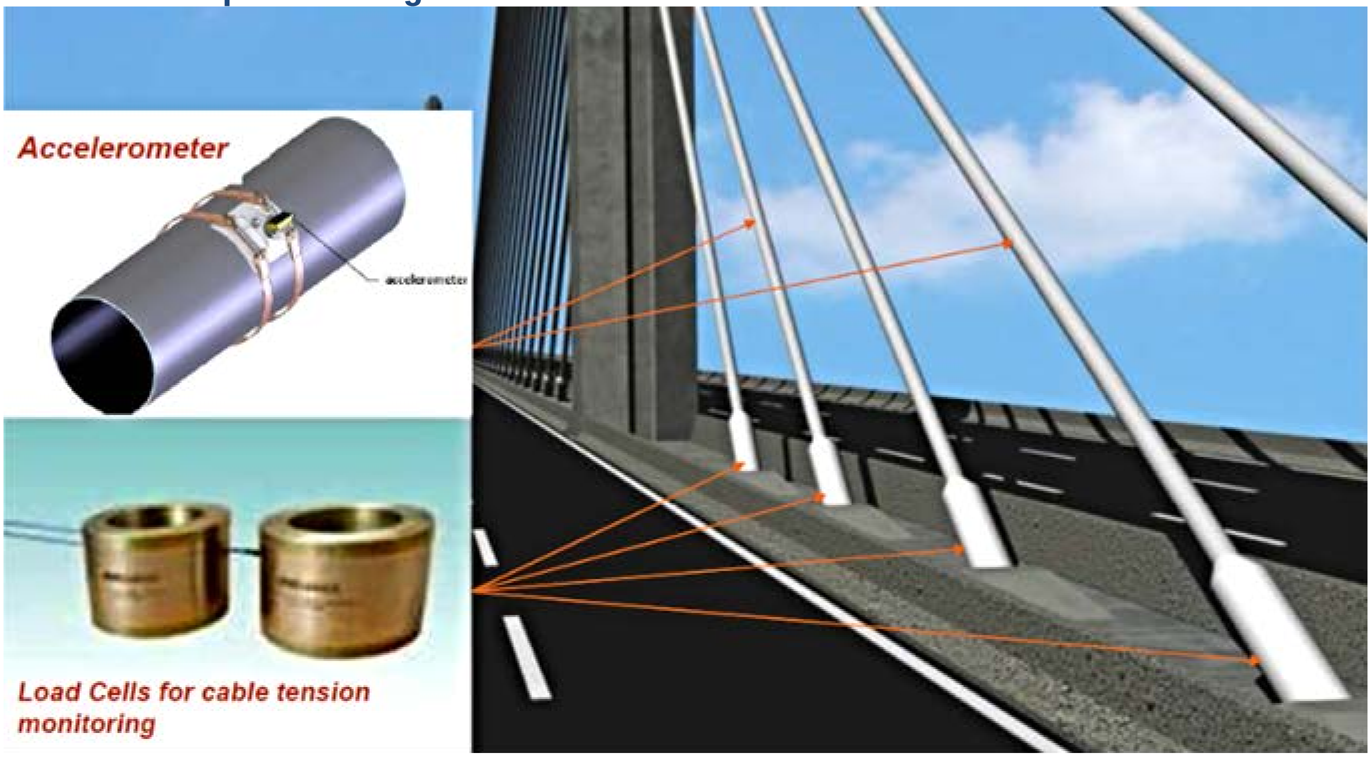


Figure 2 Monitoring Super Bridges Cables

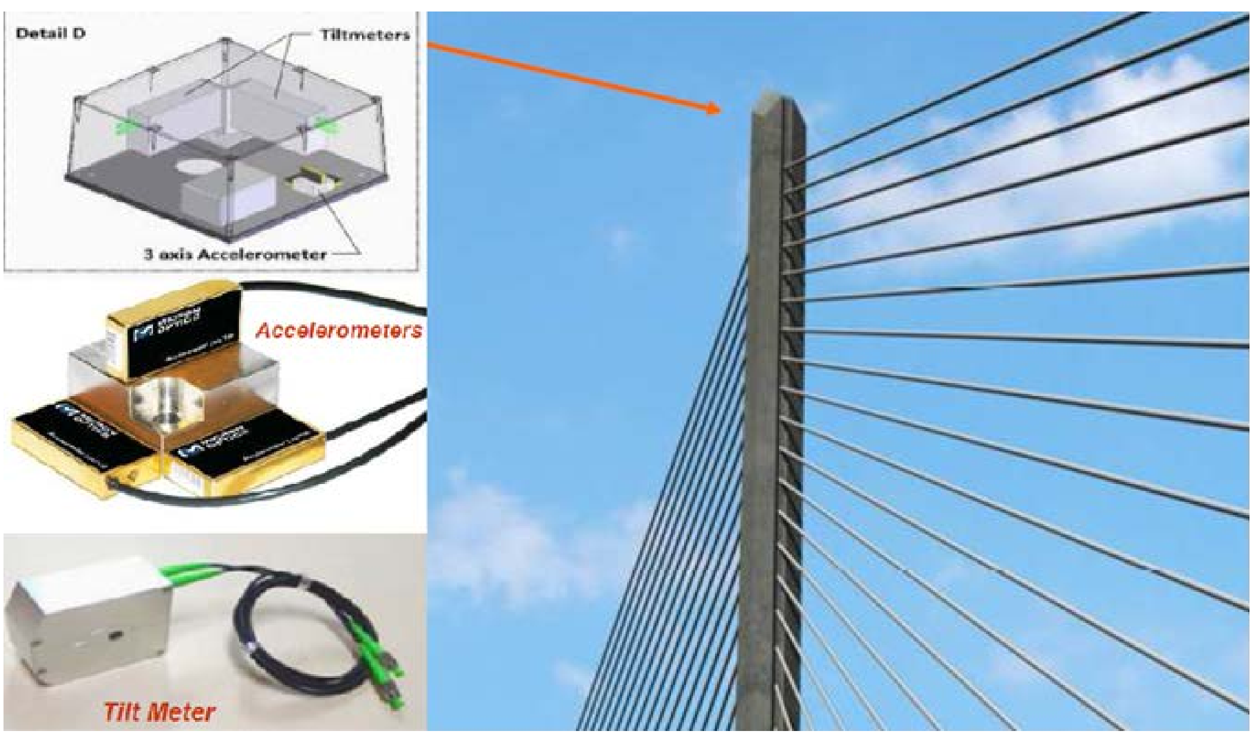


Figure 3 Monitoring Tilts & Vibrations in Piers and Abutments

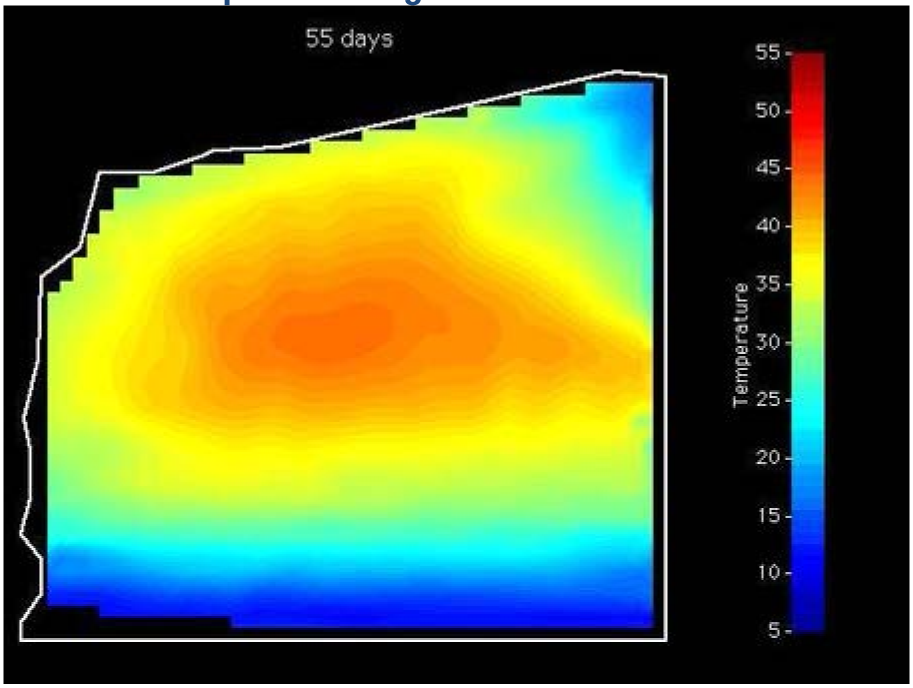
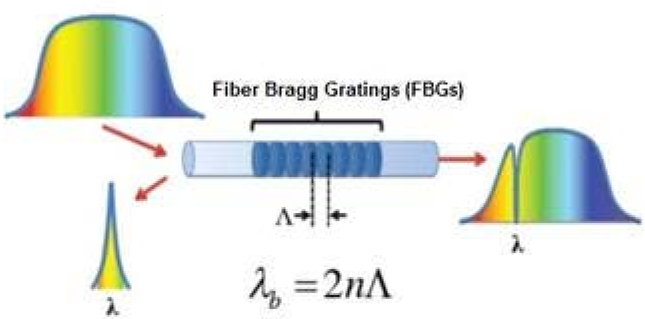


Figure 4 Concrete Cure Monitoring

Fiber Optic Based SHMS

Sensing systems based on Fiber Bragg Gratings (FBG) technology have numerous advantages compared to conventional electrical sensors. The sensor itself acts as a passive component in the sensing network allowing the integration of the sensing system and sensor even inside explosive environments where any electrical signal or sparking is prohibited. Fiber optic sensors use light as the signal carrier, rather than electric current as in conventional sensors, which renders them immune to interference from electrostatic, electromagnetic and radio sources.



The sensor can also be exposed to extreme temperatures and operate in harsh environments. Data transfer via fiber optics is already a standard in the telecommunication industry due to its wide broadband, low loss and the ability to carry the signal over long distances without needing an amplifier. Sensing systems based on FBG technology use this reliable medium to carry data acquired from both the sensors and the sensing element. The advantage of combining fiber optic technology with FBG technology is that it provides long term stability to the sensor and removes the need to recalibrate over time. The sensing element in FBG based sensors has very small dimensions and therefore our sensors can be customized and mounted on structures with minimal modification or effect on the structure's behavior. Fiber optics sensors not require a dedicated channel and cable for each sensor in order to acquire data, allowing many tens of FBGs to be integrated in a single optical fiber. This leads to very simple solution when monitoring large and complex structures. Each grating can act as an independent sensing element, which greatly simplifies large structure monitoring. This generates significant installation cost and time savings. In addition all the fiber scans be connected to a single read-out unit (FBG interrogator).

Our OEM partner, Micron Optics is an established leader of innovative optical components and laser-based equipment that advance the quality of optical measurements, allowing the sensing, imaging and telecommunications industries to make the critical measurements they need. The Micron Optics comprehensive product portfolio of tunable optical filters, swept lasers, optical sensors and sensing interrogators delivers the highest degree of measurement precision, resolution, and accuracy required for customers to yield superior, advanced solutions.

Micron Optics Sensing Products

For more information, please contact:

AdCept Technologies Pvt. Ltd.

14 Mandeville Gardens, Kolkata 700019

Contact: 98363 95767; Fax: 033 4061 2433

Website: www.adceptsolutions.com

Email: info@adceptsolutions.com