RESENSYS

Application Note

Wireless Building Structural Health Monitoring

with Resensys Wireless SenSpot™ Sensors

Wireless Building Structural Health Monitoring provides a comprehensive solution for evaluating various aspects of a building's structural integrity. Key monitoring capabilities include:

- **Monitoring cracks and deflection.**
- **Tracking settlement and inclination.**
- **Roof monitoring for snow loads.**
- **Detecting leaks, water infiltration, and moisture.**
- **Vibration monitoring for seismic and operational events.**

This application note highlights the deployment of **Resensys Wireless SenSpot™ Sensors** for remote building monitoring. These sensors enable real-time and long-term monitoring of cracks, deflection, vibration, inclination, leaks, and snow loads, ensuring structural safety and operational efficiency.

SenSpot™ Wireless Leak Detection Sensing Rope/Leaf

SenSpot™ Wireless Displacement and Crack Meter

SenSpot™ Wireless Strain Gauge

SenSpot™ High Resolution Inclinometer

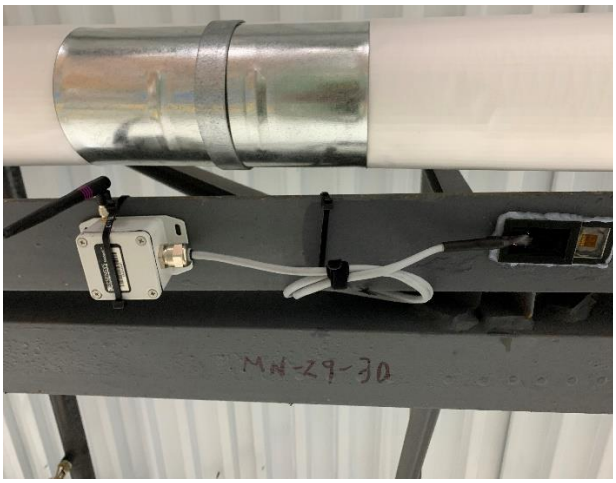
SenSpot™ Wireless Acceleration/Vibration Sensor

SeniMax™ Gateway (solar or main powered)

List of the proposed solutions, brief description and historic uses

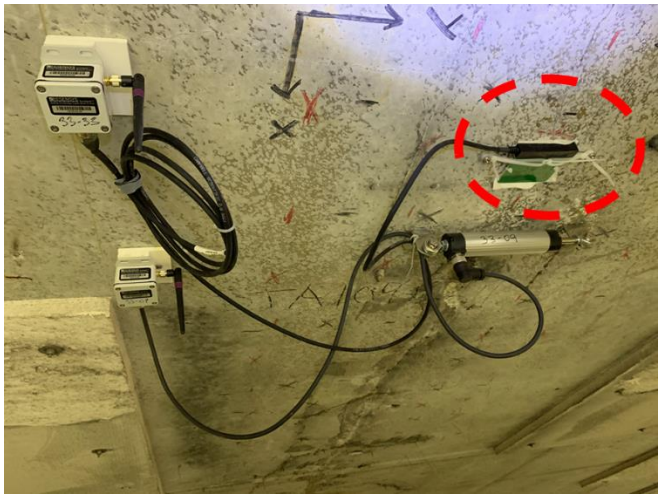
Monitoring Requirement	Resensys Proposed Solution	More Info.
Monitoring settlement & inclination	Wireless Tilt SenSpot™/ Inclinometer	Click here
Monitoring roof for snow loads	Wireless Strain SenSpot™	Click here
Monitoring cracks and deflection	Wireless Displacement and Crack Meter SenSpot™	Click here
Monitoring leak/ water /moisture	Wireless Wetness SenSpot™ node for rope type sensor (Wireless Leak Detection Sensing Cable/Rope) Wireless Wetness SenSpot™ node for leaf type sensor (Wireless Leak Detection Sensing Leaf)	Click here
Monitoring vibration seismic events (natural and man-made)	Wireless Geophone and accelerometer	Click here Click here
Data acquisition	SeniMax™ Cellular SeniMax™ Ethernet SeniMax™ Satellite	Click here

Snow Load Monitoring using Wireless Strain Gauge SenSpot™: Resensys' wireless strain gauge SenSpot™ serves a critical role in monitoring roof structures under snow loads. This sensor detects strain and stress variations, enabling real-time assessment of the impact of snow accumulation. By providing accurate data on structural behavior under varying snow conditions, it enhances decision-making for snow load management and ensures building safety.

Wireless Strain gauge SenSpot™s at roof systems of the buildings for roof monitoring under snow loads

Leak Detection with SenSpot™ Wetness Sensor: Resensys' Leak Detector (Wetness Sensor) SenSpot™plays a crucial role in safeguarding buildings against water-related damage. This wireless sensor continuously monitors moisture levels, promptly identifying leaks or excessive humidity. By providing early alerts, it prevents potential deterioration, mold growth, and structural compromise caused by water infiltration.



Wireless Wetness SenSpot™ node for leaf type sensor to measure wetness in the vicinity of cracks and joints

Wireless Wetness SenSpot™ node for rope type sensor to measure wetness along the cracks and joints

Crack and Deflection Monitoring with SenSpot™: Resensys' wireless displacement/crack meter SenSpot™ is a versatile solution for real-time crack and deflection monitoring. This sensor is strategically positioned on critical structural elements, continuously measuring any changes in

displacement, crack width, or deformation. Instantaneous data transmission to a central monitoring platform allows early detection of potential structural issues, facilitating timely intervention and preventing catastrophic failures.

Vibration Monitoring with SenSpot™ Accelerometer: The wireless accelerometer SenSpot™ offers unparalleled insights into building dynamics through vibration monitoring. This sensor captures and analyzes vibrations induced by various factors, including environmental forces, construction activities, or operational activities. Monitoring these vibrations aids in assessing structural integrity, detecting anomalies, and evaluating the impact of external forces on the building's stability.

Wireless acceleration/vibration SenSpot™ to measure floor plate vibration

Roof and Wall Inclination Monitoring with Wireless Tilt Meter SenSpot™: Resensys' wireless tilt meter is a powerful tool for monitoring roof and wall inclination. By measuring angular changes and deviations, this sensor ensures that structural elements maintain their intended

positions and alignments. Quick detection of inclination changes helps prevent structural imbalances, ensuring building safety and preventing potential collapses.

Wireless tilt meter SenSpot™ Sensors on the top section of the wall and in the different locations to measure whole wall inclination and deflection of a historical building

Wireless tilt meter SenSpot™ sensors on the roof of a building to measure and monitor inclination/tilt, deflection, and settlement of the structure

Data acquisition system: Resensys SeniMax™ is an ultra-low power and high-performance data collector and remote communication gateway. SeniMax™ communicates with SenSpot™

sensors using the IEEE802.15.4 protocol. Wireless communication between a SeniMax™ and SenSpot™ sensors uses an unlicensed ISM 2.4GHz band. A SeniMax™ has capability to transmit the aggregated data from SenSpot™ sensors to any remote data center with Ethernet or cellular data services (depending on the model). The power source of the SeniMax™ can be redundantly solar recharged or main powered.

SeniMax™ gateway (Mains Powered)

Resensys offers a well-suited, **wireless** solution for accurate **building monitoring** by obtaining automated and continuous measurements with a wide variety of **cost-effective** benefits:

- **Wireless Sensors:** No wiring, minimal time and labor for installation
- **Sensors with 10+ Years Battery Life:** No need for battery replacement, maintenance or calibration in the field
- **Easy Installation:** Self-adhesive (e.g., steel) or Flange-mount (e.g., concrete)
- **Quick Testing:** Can be installed for short-term testing, easy to remove and reuse on other structures
- **Long-term monitoring:** Designed to be used for long-term monitoring (e.g., several years).
- **Small Size and Lightweight**
- **Suitable for Different Kind of Materials:** Can be used on steel, concrete, steel, timber, and composites
- **Rugged, Weather Proof and Corrosion Resistant:** Can operate in rain, snow, ice, high humidity, salty environment and extreme weather (-40°C to +65°C or -40°F to +150°F).
- **Infrastructure Less:** Battery Operated, Energy self-sufficient, No need for communication infrastructure at the field/project
- **Provide Data Visualization and Data Analysis**
- **Immediate Alert Services:** Alerts are conducted quickly through text messages or email notifications when measurements exceed the set thresholds
- **Very High Resolution for Wireless SenSpot™**
- **Scalable System:** Able to add more SenSpot™s in a project/building without needing to be charged more for SeniMax™ gateway, monthly cloud data storage, cellular connectivity services, and SenScope™software license.
- **Rapid method of data processing:** stores data on a cloud server, with custom processing algorithms available.
- **Modifiable solution:** capable of being integrated into other technologies (3rd- party devices) easily

This system **reduces installation cost and time** for owners/authorities to get the **accurate data** they need for building monitoring. A unique capability of Resensys SenSpot™ sensor is to measure at high sampling rate and resolution, while providing **ultra-low power usage.**

A typical remote building monitoring includes the following components:

- **Wireless SenSpot™ Sensors**: are attached to structural members of the building. The required number of sensors per building of the structure depends on construction or design requirements of it and exiting conditions
- **SeniMax™**: is a wireless data logger gateway that is connected to the cellular, ethernet or satellite networks; it wirelessly collects SenSpot™ data at the site and sends it to a cloud database server (one SeniMax™ can cover as many as 80-90 SenSpot™ sensors and devices within its wireless communication range which is 1000ft-1300ft).
- **SenScope™**: software for data analysis and visualization, data export, automated alert management, thermal analysis, and corresponding data analysis. For building monitoring, Resensys monitoring software can be set to provide alerts notifications when pre-established thresholds have been exceeded to allow proactive and timely action to be taken and for required quick maintenance.

Figure below shows a picture of a practical Resensys Structural Health Monitoring (SHM) system, which can be used for remote building monitoring.

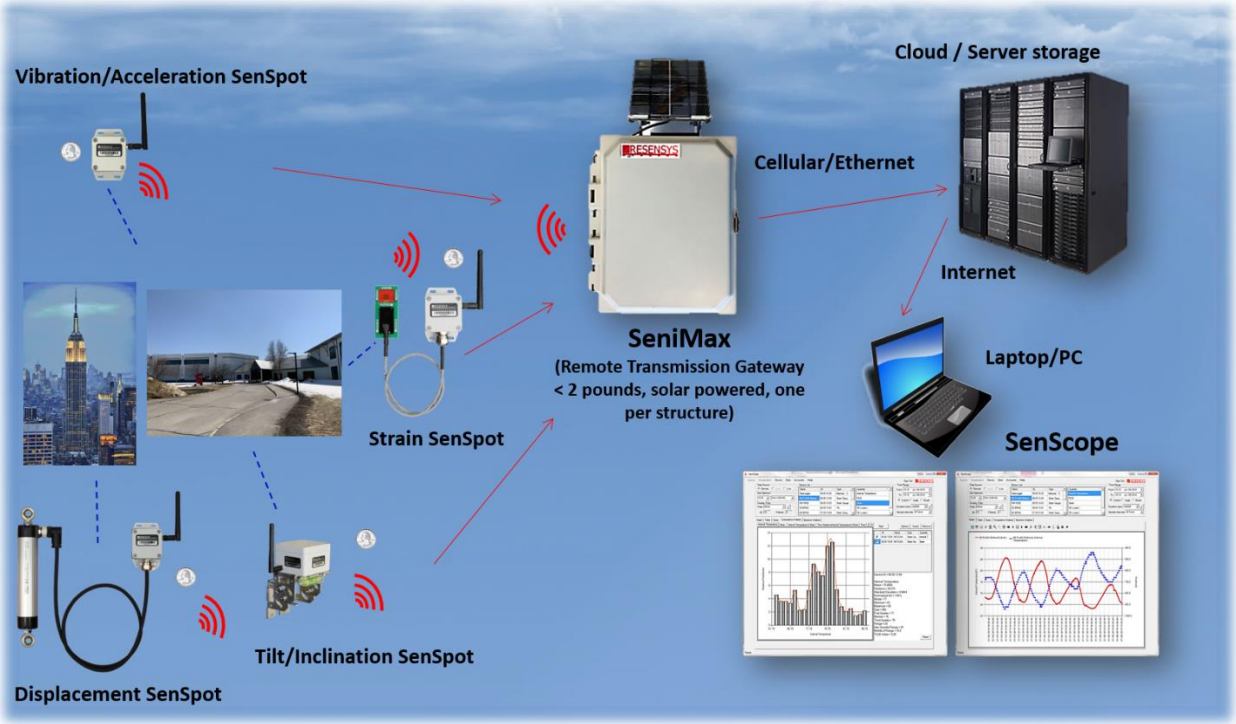


Illustration of Resensys SHM diagram based on SenSpot™ sensors for remote building monitoring