RESENSYS

Application Note

Monitoring Displacement with Resensys Wireless Displacement SenSpot Sensors

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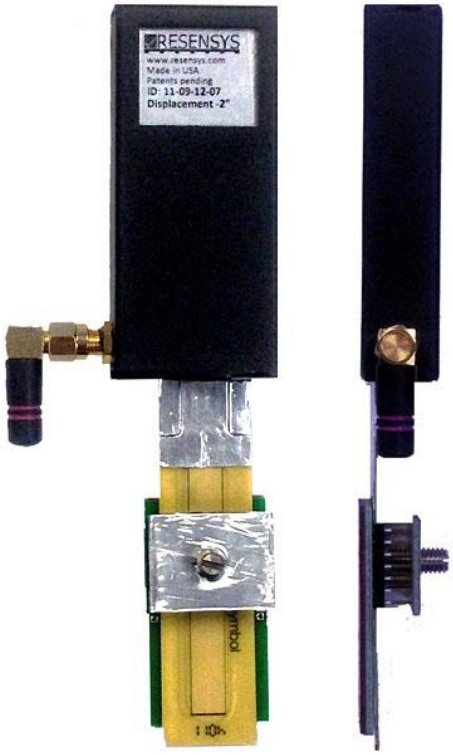
Movements of structure members within certain ranges indicate the integrity and safe operation of that structure. The Resensys structural health monitoring (SHM) solution can be used for monitoring displacement in bridge and structure members. As an important application the displacement SenSpot can be used for crack monitoring which is an important part of SHM. Cracking may cause serious damage to the structure which deteriorates its integrity and safety. Resensys displacement SenSpots are able to monitor cracks in concrete, steel and composite materials. The displacement meter shown below consists of two parts which are to be installed on the two sides of the measurement spot. The relative distance between the moving and fixed sides of the SenSpot is measured with accuracy of one tenth of a millimeter. These SenSpots are available in different measurement sizes such as 1, 2, and 4 inches.



Steel girders of old bridges mostly suffer from fatigue cracks primarily due to non-functional bearings. In cases that the bridge bearings are not functioning properly, thermal expansions and contractions of the bridge deck cause a high level of cyclic strain to accumulate in the bridges structural elements. Such a strain level could result in damage in form of cracks or deformation. Resensys Displacement meters can be used to monitor the dynamics of existing cracks. A more comprehensive solution includes tilt and strain SenSpots that are able to monitor the direction of the movements and deformations to track the correct operation of the bridge.

Visual inspection is traditionally used for crack monitoring; however, this method is time and capital consuming. Moreover, visual inspections cannot be done frequently and in many cases the measurements are unreliable and inaccurate. Therefore, the need for a system that can continuously monitor displacements and cracks to capture the healthy operation of a structure is important. Resensys manufactures wireless SenSpot sensors as a versatile sensing and wireless communication platform for long term structural health monitoring; SenSpot sensors are capable of monitoring strain, vibration, tilt, inclination, displacement, temperature, and humidity. Using this technology, any potential problem in a structure is detected in an early stage before it becomes a major issue and leads to safety compromise and/or road closure.

Important features of Resensys displacement SenSpot:

- **Ultra-low-power** (minimum of 10 years of operation without battery replacement)
- **Power source:** replaceable lithium-ion battery (non-replaceable version also exists)
- **Wireless communication** (IEEE 802.15.4)
- **Small size and lightweight**, about 90 gr. Dimensions: 1.35in × 3.0in (+ measurement length)× 0.6in
- **Easy mounting** and quick installation (Self-adhesive or Flange mount)
- **Resolution**: 0.1 millimeter
- **Working temperature:** -40 to +150°F (-40 to +65°C)
- **Long communication range:** 0.62mi (1.0Km) free space
- **Ingress Protection:** IP65

A complete Resensys SHM system includes software and hardware components for (1) the reliable collection of SenSpot data, (2) aggregation of the data, (3) the addition of timestamps, (4) communication of data to a remote server, and finally, (5) an interface for data visualization and detection of structural issues. Figure 1 shows a picture of a practical Resensys SHM system, which can be used for structural monitoring.

The system includes the following components:

- **SenSpot sensors:** which are attached to a bridge (A few tens of sensors per structure, depending on design and monitoring needs).
- **SeniMax:** which collects SenSpot data at the site and sends it to a remote server (one unit can cover as many as 100 SenSpots).
- **Repeater:** may be used to extend the range of the SenSpot sensors.
- **SenScope:** software for data analysis and visualization.

Figures 2 and 3 show some representative deployment of the displacement SenSpots. Figures 4 and 5 show some sample measurement of the displacement Senpots.

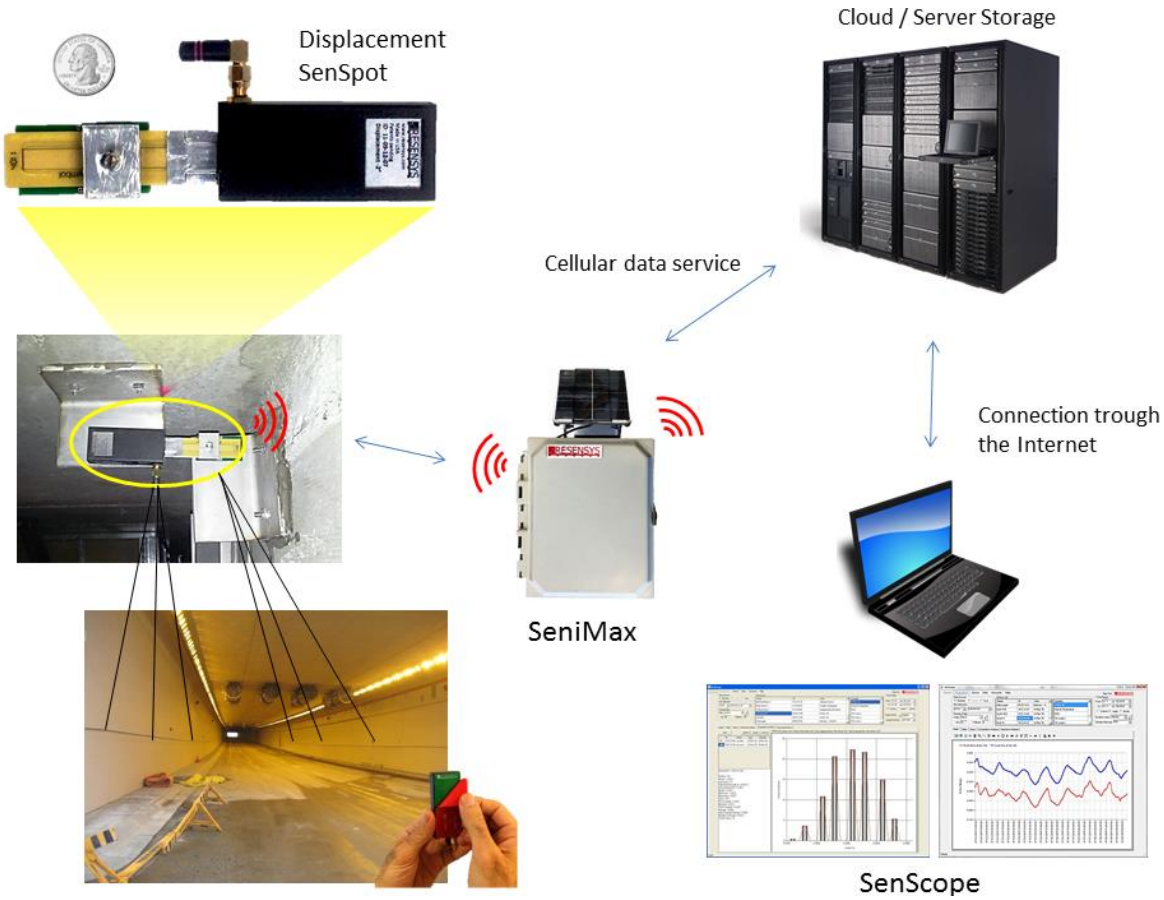


Figure 1: Illustration of Resensys SHM based on SenSpot sensors.

Figure 2: SenSpots used for measuring displacement.

Figure 3: SenSpots used for measuring displacement.

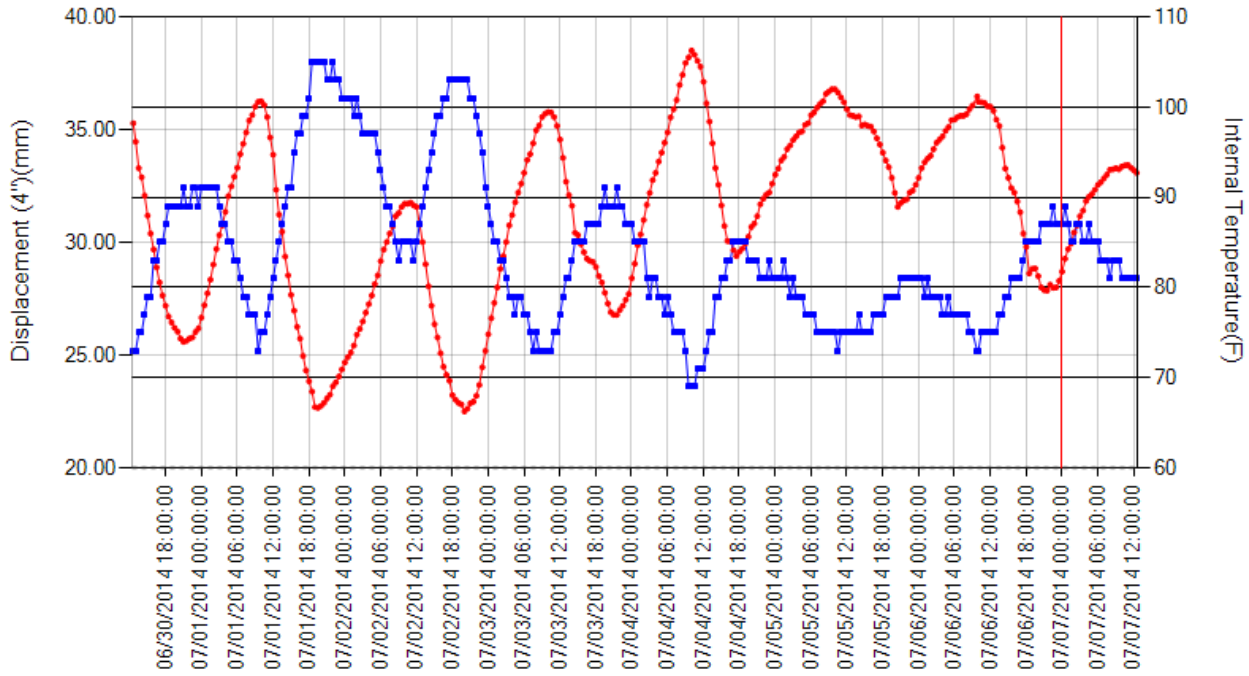


Figure 1: Measured temperature and displacement of one SenSpot.

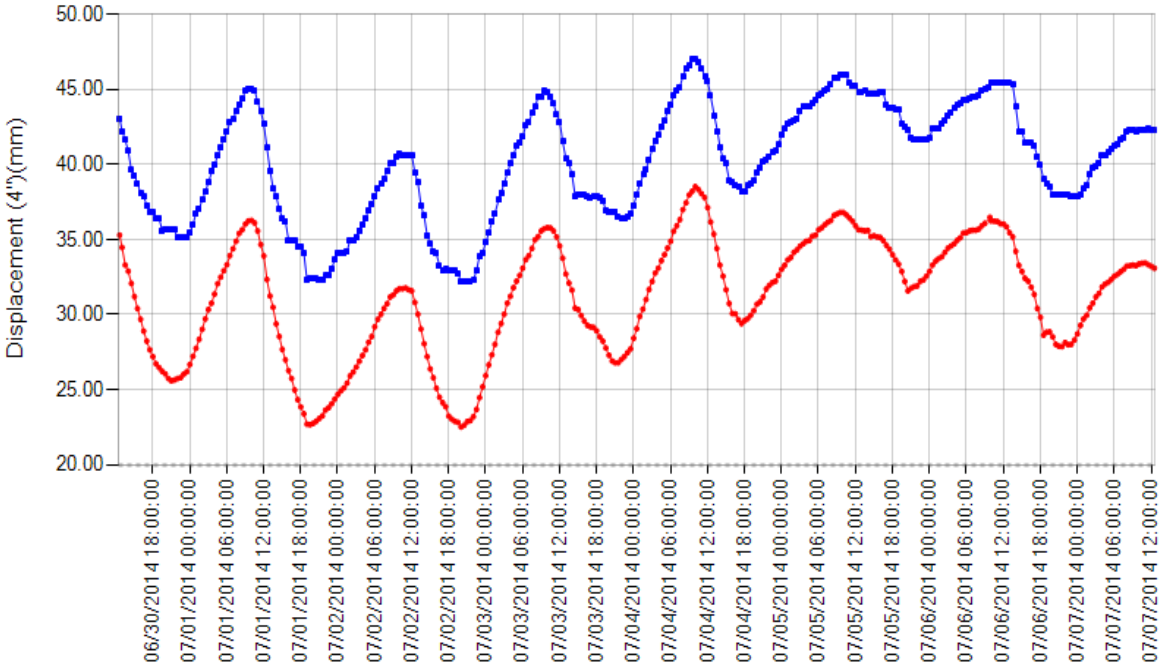


Figure 2: Comparison of measured displacements of two SenSpots.