RESENSYS

Application Note

Detecting Overweight Loads on Load-Posted Bridges Using Resensys Wireless Strain Gauges & Solar Powered Cameras

Overweight vehicles can cause harm for the structural health of bridges. As one of the important and helpful applications of the Resensys wireless monitoring system, **Resensys wireless strain gauge SenSpot™ sensors** can detect instances of a load-rating violation. In this application, strain produced by a known load (e.g., a test truck) is used to estimate maximum strain expected as a result of maximum legal load. This maximum sets the threshold for detecting overweight trucks on the bridge. Figure 1 shows a wireless strain gauge SenSpot™ at a truss of a bridge.

In a more complex implementation of such a detection system, a **Resensys wireless solar powered camera** was used to take pictures upon detecting loads which exceed the rated limits. The combination of wireless strain gauge SenSpots with wireless solar powered cameras proved to be a very effective and easy-to-implement method for detecting load-rating violations. The camera is solar powered and it is not connected to any external source of electricity is powered off, unless wireless strain gauges detect unusual strain, at which point the camera takes a photo. A picture of the camera is shown in Figure 2.

Figure 1: Wireless strain gauge SenSpot™ at a truss of a bridge

Figure 2: Resensys wireless solar powered camera installed on the pier of a bridge to provide complete visual feedbacks of overweight loads

Case Studies and Previous Projects:

A number of case studies where bridges were monitored using the Resensys monitoring system showed that violation of load-rating happens frequently on some bridges:

1- **Monitoring System on a Truss Bridge:** Since the installation of the Resensys monitoring system on a truss bridge, the wireless strain gauge SenSpot™ sensors have been showing frequent instances of strain produced by live loads that appear to be larger than the expected strain produced (60-70 microstrain) by the legal loads on the bridge, which is rated at 23 Tons. To better understand the nature of such loads, the Resensys team added a wireless camera to obtain complete and detailed visual feedback from the instances of apparent violation of the rated load.

   The graph and figure below show instances of excessive load event detection on this bridge.

   Figure 3 visualizes strain spikes detected on a few selected members on a truss bridge. Peak strain change is close to 100 microstrain. Also, Figure 4 shows the photo of the truck captured by the camera on the bridge. The time tag from the camera is 08/20/21 at 09:22:40am, which matches the time of the high strain event.

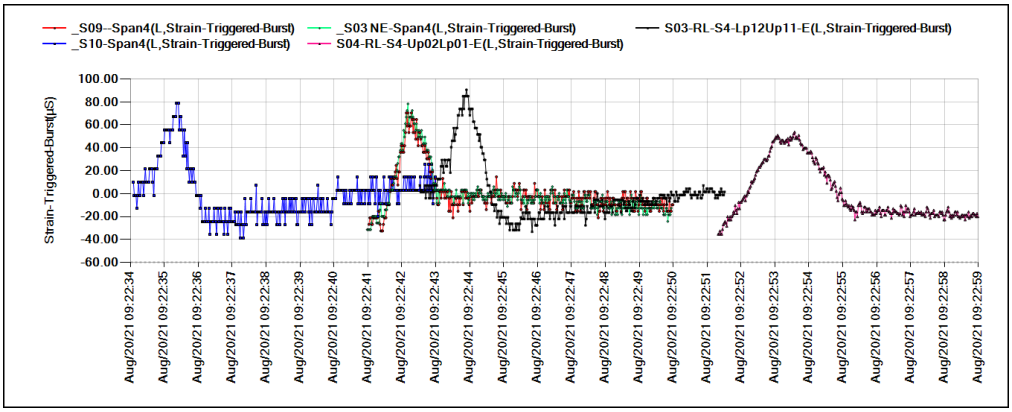

Figure 3: Graph of strain spikes detected on a few selected members on a truss bridge. Peak strain change is close to 100 microstrain.

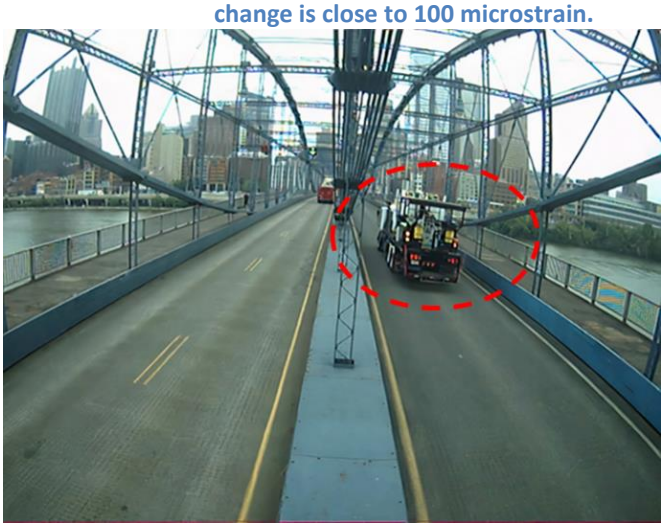

Figure 4: The photo of the truck captured by the camera on a truss bridge. The time tag from the camera is 08/20/21at 09:22:40am, which matches the time of the high strain event.

2- **Monitoring System on a Highway Bridge:** A Resensys structural health monitoring system (including a wireless solar powered camera and wireless strain gauge SenSpot™ sensors) were installed on a highway bridge to detect overweight loads/trucks. Examples of overweight trucks that were captured by the wireless solar powered camera are shown in Figure 5.

Figure 5: These are the photos of the overweight trucks captured by the camera on a highway bridge. The time tags from the camera match the time of the high strain events.

Resensys System Benefits:

The Resensys system offers an accurate and **wireless** solution to the problem of **monitoring instances of overweight loads on bridge** (including obtaining strain measurements and getting visual feedbacks) with a wide variety of **cost-effective** benefits:

- **Wireless Strain Gauge SenSpot™:** No wiring, minimal lane closure for installation
- **Wireless Solar Powered Camera:** No need for electricity
- **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**
- **Being 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 bridge
- **Provide Data Visualization and Data Analysis**
- **Very High Precision for Wireless Strain Gauge SenSpot™:** 1 microstrain
- **High Sampling Rate for Wireless Strain Gauge SenSpot™:** Typically, 20-100 samples per second
- **Quick and Complete Assessment of Conditions after high strain events**

This system **reduces installation cost and time** for owners/authorities to get the **accurate data and detailed visual feedbacks** they need for load-rating violation on bridges. A unique capability of Resensys wireless strain gauge SenSpot™ sensors is to measure at high sampling rate and resolution, while providing **ultra-low power usage**.

Illustration of Resensys Structural Health Monitoring (SHM) System:

A typical Resensys system for monitoring instances of overweight loads on bridges includes the following components:

- **Wireless Strain Gauges SenSpot™:** are attached on critical elements as determined by inspection, finite element modeling, load rating model or authority's/client's suggestion. The number of gauges required per structure is usually dependent upon the design, existing issues on members and project needs.

- **SeniMax™:** is a wireless data logger gateway that is connected to the cellular 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 100 SenSpot™ sensors and devices within its wireless communication range).

- **Wireless Solar Powered Cameras:** are installed on top of the piers or light posts to detect and capture the source/picture of overweight load/truck in high strain event. So, it is placed towards the locations/sides that vehicles come to the piers or light posts. Required number of cameras are determined according to project requirements. Camera can be integrated with SeniMax™. Thus, separate SeniMax™ is not needed for data acquisition.

- **SenScope™:** software for data analysis and visualization, data export, automated alert management, thermal analysis, and obtaining sources/pictures of overweight loads/trucks.

Figure 6 shows a picture of a practical Resensys SHM system, which can be used for monitoring instances of overweight loads on bridges.

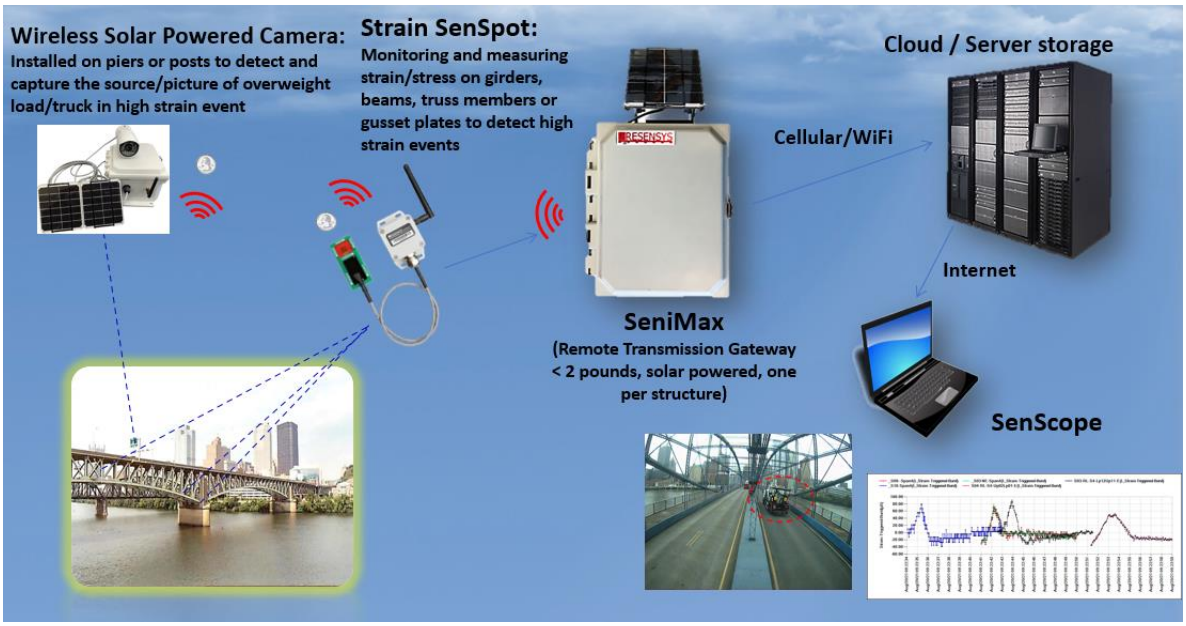

Figure 6: Illustration of Resensys SHM based on SenSpot™ sensors for monitoring instances of overweight loads on bridges