Intelligent segments

PATENTED

Patented device for monitoring the stress state of a concrete element

sixense

YOUR CHALLENGES

Understanding the **stresses** in **prefabricated segments** is critical both during the **construction phase** of the **structure** (**tunnel** or **viaduct**) and for **monitoring** its **health** throughout its lifecycle.

During construction, it's essential to **monitor** the **stresses** endured by the **segments** to **ensure** they do not exceed **permissible limits**. These forces arise from transport and handling, placement, assembly, and the construction sequencing of the subsequent structure.

In the **final phase**, **monitoring the stresses** in the **segment** helps to **ensure** it is not subject to **new stresses** due to **environmental changes**. The stress state also serves as a **good indicator** of the element's **aging** condition.

Handling of segments for placement in a tunnel constructed using a tunnel boring machine. →

OUR SOLUTION
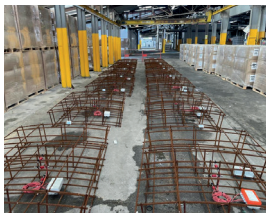
Intelligent segments incorporate an **autonomous stress monitoring** system. The system is installed from the manufacturing stage of the element and is immediately operational, allowing **monitoring** of **stress variations** from **concrete hardening** to **segment installation** and throughout the **entire life cycle** of the segment.

← Intelligent segment rebar cages. View of sensors and recorders.

THE BENEFITS

- **Known stress state** from the manufacture of the element **throughout its lifecycle,**
- **Automatic** and **continuous measurements,** with possible **alarms,**
- An **autonomous** measuring **device,**
- Knowledge of the **stresses in the element** allows for **back-analysis** and **optimisation** of future structures. It's an essential measure for implementing an effective **observational method,**
- Intelligent segments facilitate **long-term monitoring** of the structures they comprise,
- They are indispensable tools for monitoring structures made with **innovative materials** (low carbon, ultra-low carbon materials, and others).

Analysis of intelligent segment results from concrete pouring to segment placement.

Sixense's ⊕

- Measurement is our business; client satisfaction is our motivation.

- We are the global specialists in precise and useful measurements.

- Combining measurement expertise, geotechnical and structural knowledge, and mastery of on-site interventions, our teams understand your needs and know how to meet them.

CONTACT US

› contact@sixense-group.com

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TECHNICAL PRINCIPLES

- Measures of **microdeformation** using vibrating wire strain gauges,,
- **Stress calculation** by Hooke's law: $\sigma = E \times \varepsilon$
- **Strain gauges connected** to a mini **autonomous recorder integrated** into the segment,
- **Continuous recording,**
- **Data retrieval** using an **IoT communication gateway** communicating via long-range radio with the recorders (range of 400 m),
- Option to **adapt** the **measurement frequency** depending on the construction and monitoring phases,
- Use of **long-life batteries** (lifetime > **10 years** for an **acquisition every 6 hours**). **Access** to the logger for **battery replacement** is available.

Installation of the recorder on the intelligent segment cage →

APPLICATIONS

- **Tunnel** segments made using a tunnel boring machine,
- Segments for **bridges** and **viaducts**,
- Any other **structural concrete element** (prefabricated or cast in place).

SPECIFICATIONS & LIMITATIONS

- **Operating temperature:** from -20 °C to +65 °C (withstands the temperature increase during concrete setting),
- Technical characteristics of the **strain gauges:**
  - **Measurement range:** 3000 µε
  - **Accuracy:** 0,5% FS – **Repeatability:** 1 µε
- Necessity to know the **Young's modulus** of the concrete to transform the microdeformation measurements into stress.

RELATED TOOLS AND SERVICES

- We offer a **turnkey service** starting from placement at the prefabrication factory,
- Possibility to use **other types of sensors** integrated into the structure (**inclinometer, load cell,** or others),
- Data visualization on our **Beyond Monitoring web platform**,
- **Structural analysis, aging analysis.**

REFERENCES

- Grand Paris Express, Line 18 Package 1, France
- Tunnel Nice Tramway T2, France

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