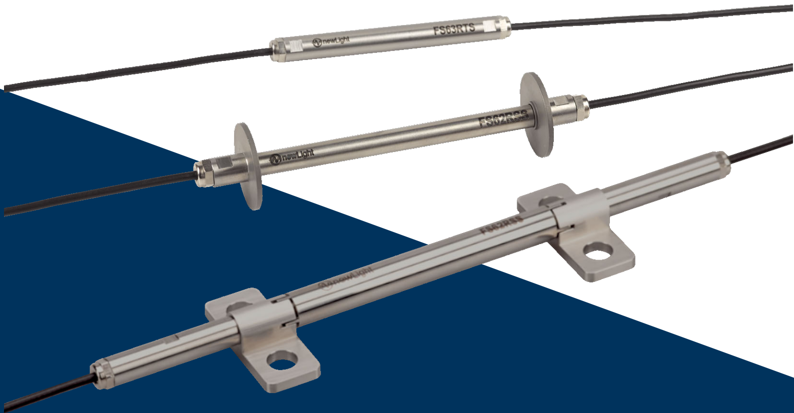
ENGLISH

Mounting Instructions



FS62RSS, FS63RTS

Rugged Strain and Temperature Sensors

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1 GENERAL INFORMATION

The following instructions refer to the installation procedure of FS62RSS Rugged Strain Sensors and FS63RTS Rugged Temperature Sensors.
These sensors can be delivered individually or in arrays of sensors pre-assembled at HBK FiberSensing facilities.

Material Numbers	
Strain Sensors	**Temperature Sensors**
K-FS62RSS	K-FS63RTS
	1-FS63RTS-ARM/1515
	1-FS63RTS-ARM/1525
	1-FS63RTS-ARM/1535
	1-FS63RTS-ARM/1545
	1-FS63RTS-ARM/1555
	1-FS63RTS-ARM/1565
	1-FS63RTS-ARM/1575
	1-FS63RTS-ARM/1585
	1-FS63RTS-ARM/1595
Sensor Arrays	
K-FS76ARM	

1.1 Environment Considerations

1.1.1 Packaging Disposal

The packaging of this equipment is designed to protect it from damage during transportation and storage. It is also made of materials that can be recycled or reused, in accordance with the European Union's waste management regulations to minimize its environmental impact.

If you plan to move your equipment to different locations it is advisable that you keep the original package for reuse. This will not only grant proper protection for transportation, but also ensure the reduction of waste creation.

Packing boxes include a label with information on the materials used on that specific package.

Fig. 1.1 Packing label example

Please follow the instructions below to dispose of the packaging properly and responsibly and contribute to the preservation of our planet. Thank you!

To dispose of packaging, you should:

- Remove any labels, adhesives, nails, staplers or caps that are not part of the same material.
- Rinse the packaging with water to remove any residues or dirt.
- Flatten or fold the packaging to reduce its volume and save space (except for glass that should not be crushed).
- Separate the packaging by material and place it in the appropriate recycling bin or bag.

Most of our packing are made of paper and plastic and aimed to be reused or recycled, but they are not appropriate for food containing. Please consult the chapter “Packing Symbols” for more detailed information about the packing materials used by HBK FiberSensing, marked in the packing label of each product delivered to customers.

Packaging Symbols

Packing materials are marked with the correspondent symbol for guidance.

Not appropriate for food

Recyclable

The recycling symbols for the different materials include numbers and letters that identify the material type. For example, PET (polyethylene terephthalate) is marked also with the number 1, and PE-HD (high-density polyethylene) is marked with the number 2. For paper (PAP) 20 corresponds to corrugated cardboard and 22 to paper as seen in newspapers, books,…

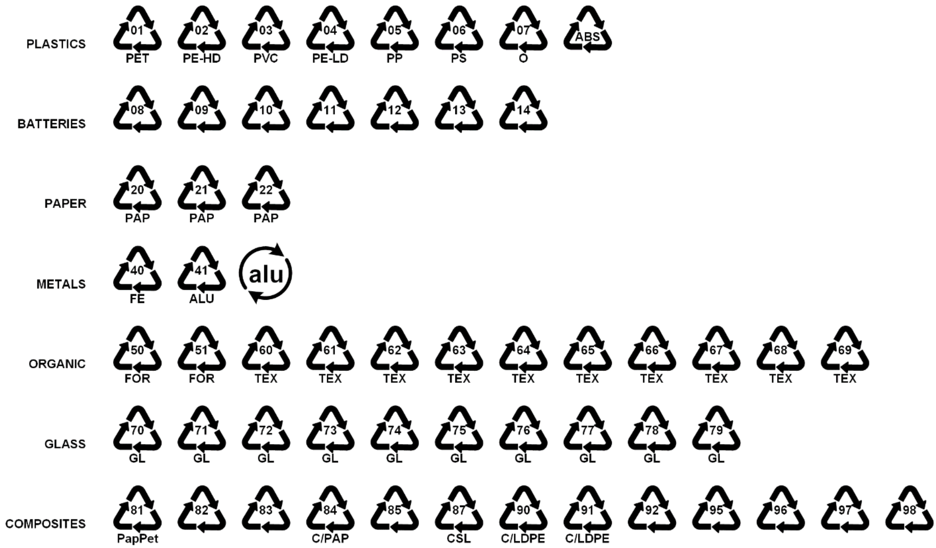

Fig. 1.2 Recycling symbols

Plastics

Plastic packaging materials are commonly bags, films, trays, blisters or containers.

Batteries

Batteries are not part of the packaging, but they may be included in the equipment or its accessories. Please refer to section 2.1.1 Disposal of your old appliance for more information.

Paper

Paper packaging materials are commonly boxes, cartons, envelopes, or labels.

Metals

Metal packaging materials are commonly cans, foils, caps, or wires.

Organic

Organic packaging materials could be wood, cork, or cotton and are made of natural or biodegradable materials that can be composted or reused.

Glass

Glass packaging materials are bottles, jars, or vials.

Composites

Composite packaging materials are made of layers of different materials, such as paper, plastic, and aluminum. They are marked with a recycling symbol and a letter that indicates the composition of the packaging. For example, PAP is for paper and plastic, and ALU is for aluminum.

1.2 Marking used in this document

Important instructions for your safety are specifically identified. It is essential to follow these instructions to prevent accidents and property damage.

Symbol	Significance
⚠ **CAUTION**	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *can* result in slight or moderate physical injury.
Notice	This marking draws your attention to a situation in which failure to comply with safety requirements *can* lead to damage to property.
Important	This marking draws your attention to *important* information about the product or about handling the product.
Tip	This marking indicates application tips or other information that is useful to you.
Information	This marking draws your attention to information about the product or about handling the product.
Emphasis *See …*	Italics are used to emphasize and highlight text and identify references to sections, diagrams, or external documents and files.
▶	This marking indicates an action in a procedure

2 SENSOR INSTALLATION

2.1 Introductory notes

When mounting FS62RSS and FS63RTS sensors, please pay attention to the following:

- Handle with care.
  These are precision sensors and so their achievable accuracy highly depends on correct mounting.
- Do not overload the sensors.
- Avoid lateral forces or torque.
- Handle the cables with care before fixing to avoid damage. Do not hold the sensor by the cables.
- Nuts from the cable exiting from the sensors are part of the sensors' body and must not be unfastened.

Notice

The FS62RSS and FS63RTS sensors are precision measuring elements and need to be handled carefully. Dropping or knocking the sensors may cause permanent damage. Make sure that the sensors cannot be overloaded, including while they are being mounted.

2.2 Embedded Strain Sensor

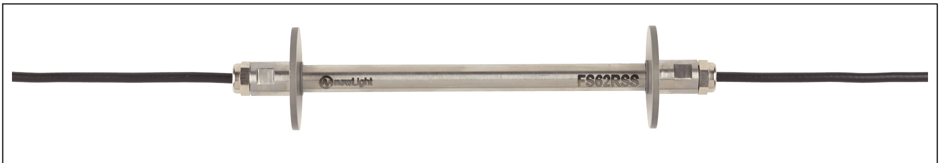

Fig. 2.1 FS62RSS Rugged Strain Sensor on its Embedded version

2.2.1 List of materials

Included material
FS62RSS Rugged Strain Sensor (Embedded Version)

Needed material
Fixation: Plastic cable ties or metallic wire (~Ø 0.8 mm) Mounting accessory 1-FS84-FS62RSS01 (optional)
Protection: Silicone or foam Flexible and resistant protection tube Protection box to be embedded (optional)
Identification: Colored tape/heat shrinking tube/…

2.2.2 Preparation of the installation area

The Embedded version of the FS62RSS Strain Sensors are prepared to be embedded in concrete.

Important

Always pay extreme attention to the preparation and coordination with the concreting team. These sensors are sensitive equipment and it is advisable that the installation is performed as closer in time as possible to the concreting.

▶ Ensure that for each sensor installation area there is enough room for the correct positioning of the sensor.

Tip

Plan and prepare as much in advance as possible the cable routing protections within the embedded areas. *See section 2.2.4 Routing and protecting the cables on page 14.*

2.2.3 Fixing the sensor

▶ Carefully take the sensor out of the box.

The FS62RSS Rugged Strain Sensor to be embedded in concrete can be installed in different orientations for different measuring purposes. For example, it might be desired that the sensor is hanging in between rebars (*Fig. 2.2 A*), or that it is next to the rebar and aligned with the reinforcement bar (*Fig. 2.2 B*). The sensor should be fixed on the desired position in a way that is will not move and will not change its alignment during concreting.

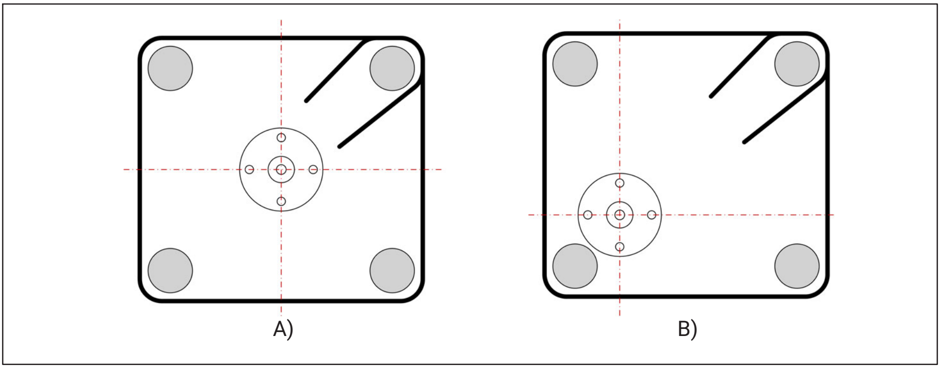

Fig. 2.2 Sensor positioning.: A) measuring iniside concrete; B) measuring along the rebar

▶ Place it on the structure with the desired orientation. Make sure that that the interface of the sensor and the cables are not being forced.

Tip

Sensor anchors include fixation holes that can be used to support the correct placing of the sensor via plastic cable ties or wires.

Measuring inside concrete

To measure strain of concrete the sensor needs to be standing in between rebars. In that case the sensor needs to be installed hanging from the rebars.

▶ Use plastic cable ties or a thin wire (suggested diameter: ~0.8 mm) with sufficient length to secure the sensor at the desired location on a fixed structure.

▶ Thread the wire or cable tie through the holes on the sensor anchors.

Fig. 2.3 Threading the securing wire

- Secure the cable tie or wire to the existing fixed points.
- Adjust the tension in all directions to position the sensor correctly.

Fig. 2.4 Sensor in place between the bars

Measuring along the rebar

For strain information of the concrete next to the rebar, the sensor needs to be installed aligned with the rod.

- If you do not wish to use the mounting accessory, secure the sensor directly to the bar using cable ties.
- When using the mounting accessory, prepare it by inserting the provided cable ties into the fixation points.

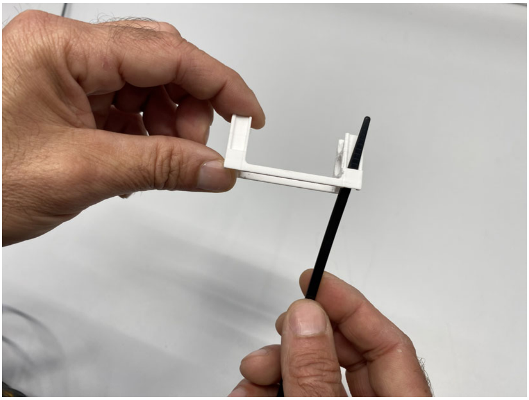

Fig. 2.5 Preparing the cable ties on the mounting accessory

- Place the sensor centered on the mounting accessory and pull the cable ties from the opposite side to secure the sensor to the accessory.

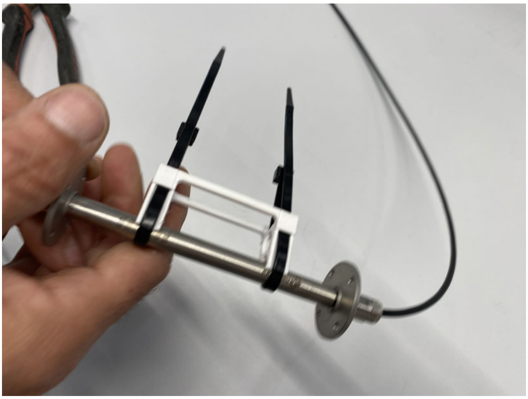

Fig. 2.6 Securing the sensor to the accessory

- Align the mounting accessory with the rebar and secure the cable ties to it.

Fig. 2.7 Securing the sensor to the bar

2.2.4 Routing and protecting the cables

The ruggedized sensor's design includes protected cables for such an environment. Further protection of cables should be performed on the cables path over critical areas, for example, when exiting the concrete.

Fig. 2.8 Highlighted protection tube on delicate areas

HBK FiberSensing recommends two different approaches regarding the access to the sensors connections:

If the stripping of the formwork can be closely controlled, the protection tube can pass directly through a hole in the formwork (Fig. 2.3 and 2.4). Later, when the formwork is removed, a box can be placed over the exit of the cables so that connections can be conveniently protected.

Fig. 2.9 Direct exiting from the formwork (inside view)

Fig. 2.10 Direct exiting from the formwork (outside view)

Fig. 2.11 Protection box for optical connections protection examples

Information

Make sure the construction workers are instructed that the boxes and cables must be handled with care.

Sensors and Arrays are delivered with identification tags:

- Next to each sensor with its serial number;
- Close to the connector or cable termination with the sensor's or the array's serial number.

If there are extensions to these cables it is advisable to mark the end of the cables so that the sensors can be identified later on. Use, for example, colored tape or heat shrinking tube.

Fig. 2.12 Sensor's identification

Information

Be extremely careful with the heat application on the shrinking tube for the buffer is sensible to high temperatures.

- Control the path of the buffers with plastic wire clamps ensuring that the exposed buffers (before entering the protection tube) do not have tight curves and that it is protected by the reinforcement during the concreting operations and vibration (*Fig. 2.13 and Fig. 2.14*).

Fig. 2.13 Cable routing

Fig. 2.14 Cable routing

Tip

Carefully secure the splices in two points in case sensors are delivered with longer cables or in arrays (Fig. 2.15).

Fig. 2.15 Splice fixation

▶ Close the end of the protection tube with polyurethane foam, silicone or similar (*Fig. 2.16*).

Fig. 2.16 Protection tube sealing

2.2.5 Concreting

The concreting process is a tough operation on the sensors, especially if mechanical vibration is applied to the concrete.

Fig. 2.17 Sensor during concreting

One way of protecting the sensors from the vibrating equipment, as well as from the heavier aggregates, is to place a net on top of the sensors location.

Fig. 2.18 Sensor area protection

Information

Despite all the protections you may have planned, make sure the operations are closely supervised and inform the workers about the installed sensors.

2.3 Surface Mount Strain Sensor

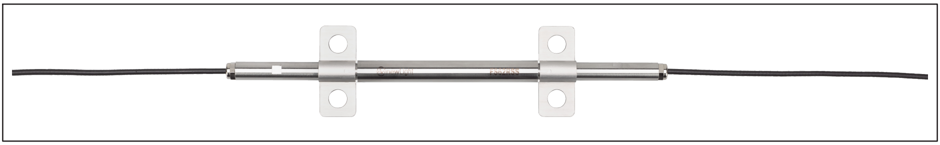

Fig. 2.19 FS62RSS Rugged Strain Sensor on its Surface Mount version

2.3.1 List of materials

Included material
FS62RSS Rugged Strain Sensor (Surface Mount Version)

Needed Equipment
Drilling machine

Needed material
Fixation: M6 Anchors, Flat Washers, Bolts and Thread Locking Adhesive Suggested: MKT B 6-10-20/67 HCR; Loxeal 55-03 Thread Locker
Protection: Protection box or cover to be embedded (optional)
Hammer
Drill bit diameter 6mm
Spanner Wrench 10mm

2.3.2 Preparation of the surface

The surface where the sensor is to be installed should be regular.

Make sure of that there are no major irregularities that could interfere with the sensor's fixation to the structure.

Fig. 2.20 Regularizing the surface

- Using a hammer and a chisel or similar, remove major irregularities that could interfere with the correct positioning of the sensor.
- Mark the position of holes to drill considering the measurement direction and the sensor characteristics.

2.3.3 Preparing anchoring points

For fixing the sensor needs four anchoring points, two to each side of the sensor, 120 mm apart.

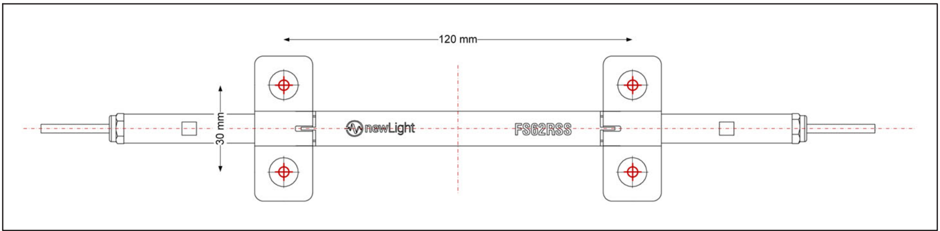

Fig. 2.21 Fixing points marking

- Mark the four points aligned with the desired measuring direction and centered with the measurement point.

Tip

A paper gauge is provided to support on the drilling position. Align it with the desired direction and centered at the marked point measuring point and attach it to the surface. Drill through the paper.

Information

The following procedure refers to the installation on a (cracked/non-cracked) concrete surface. For others base materials, procedure adaptations or specially designed accessories might be necessary.

- Drill the holes according to the chosen anchors.
  (Suggested hole depth: 55 mm)
- Clean the holes and remove the inside dust.

Fig. 2.22 Drilled and clean hole

▶ Install the anchors in the holes, leaving 10 mm outside.

Information

An hammer might be needed for this operation.

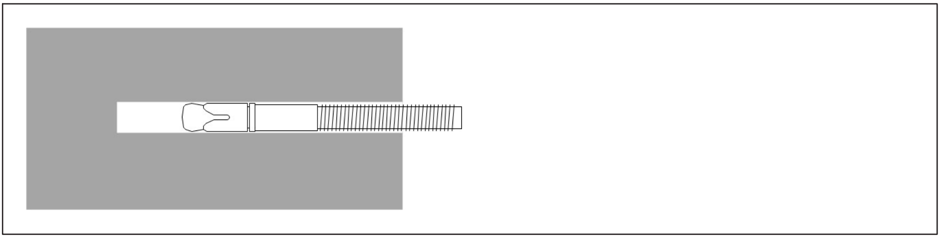

Fig. 2.23 Inserted anchor

▶ Verify the screws position with a measuring tape.

▶ Introduce the washes and the nuts.

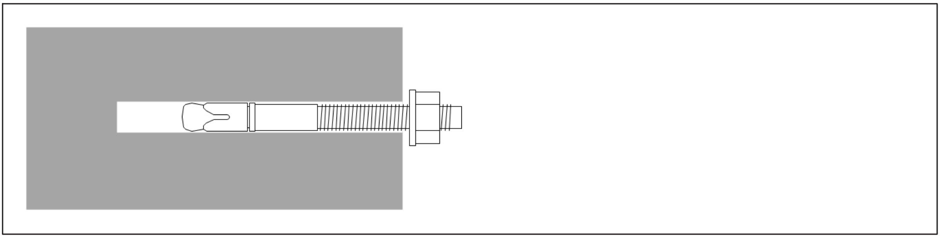

Fig. 2.24 Fastening the nut

▶ Insert the washes and fasten the nuts tightly.
(Recommended tightening torque: 5 Nm)

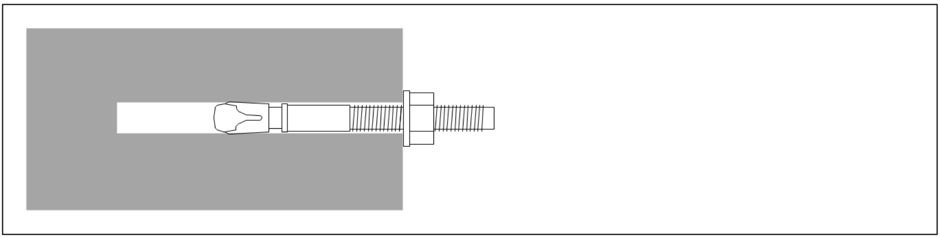

Fig. 2.25 Tightening the nut to open and secure the anchor

▶ Remove the nuts and the washes.

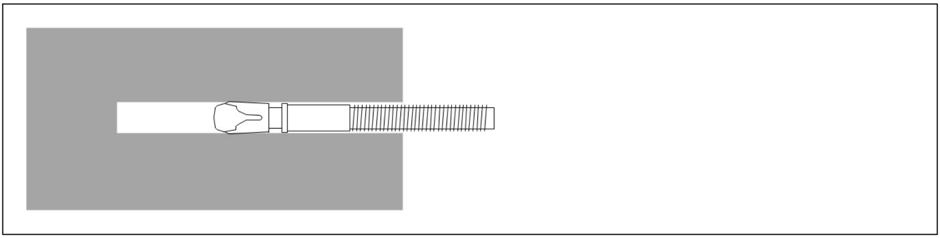

Fig. 2.26 Secured anchor

2.3.4 Installing the sensor

- Carefully take the sensor out of the transportation box and place it on the supports.

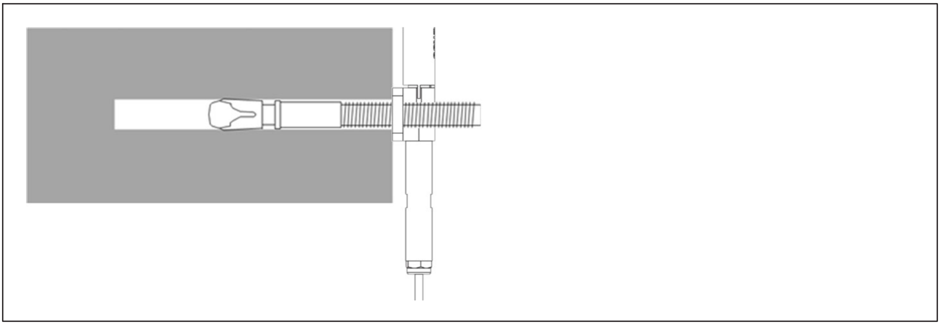

Fig. 2.27 Placing the sensor on the anchors

- Slightly fasten the nuts following the opposing diagonal direction (first nut 1, then 4, then 3 and 2).

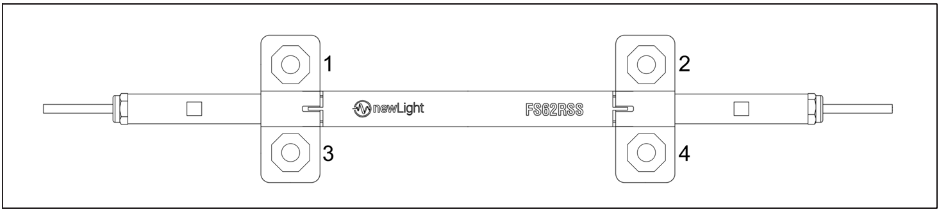

Fig. 2.28 Nut position

- Adjust the sensor to its correct direction.
- Tightly fasten the nuts following the same procedure. Recommended minimum torque of 5 Nm.

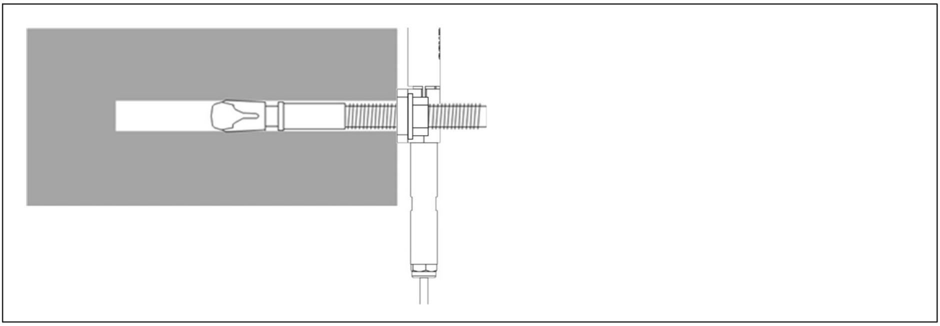

Fig. 2.29 Fastened sensor

2.3.5 Routing and protecting the cables

Sensor cable should be routed ensuring that cables are not hanging and curvatures are kept within the limits for the used cable The cable should be fixed by means of clamps or strong tape, for example (*Fig. 2.30*). In case there are splice protections, ensure that the splices are also well fixed.

Fig. 2.30 Cable routing

Plastic corrugated tubes can also help routing the longer lead cables that will connect to the interrogator (*Fig. 2.31*).

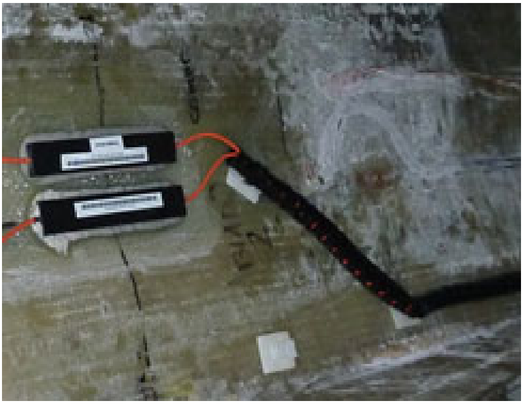

Fig. 2.31 Cable protected with corrugated tubes

Excess cable should be coiled and stored in a suitable IP case, so it can be used in case of network refurbishment (*Fig. 2.32*).

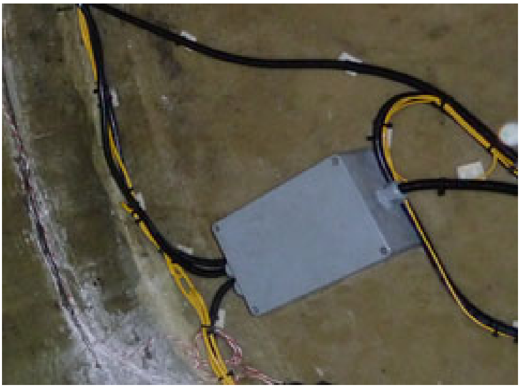

Fig. 2.32 Protection boxes for extra cable and connections

2.3.6 Protecting the sensor

The surface mount version of the strain sensor is prepared to withstand outdoor conditions. However, it might be necessary to provide further mechanical protection. For example, by using a plastic or metallic cover. Protection accessories are not provided.

2.4 Temperature Sensor

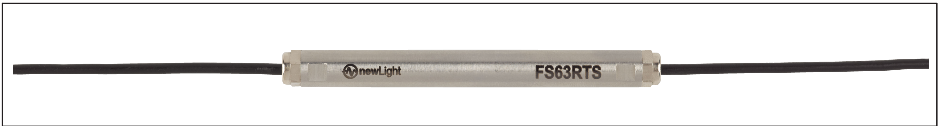

Fig. 2.33 FS63RTS Rugged Temperature Sensor

2.4.1 List of Materials

Included material
FS63RTS Rugged Temperature Sensor

Needed material
Fixation: Plastic cable ties or tape
Protection: Silicone or foam Flexible and resistant protection tube Protection box to be embedded (optional)
Identification: Colored tape or heat shrinking tube

2.4.2 Preparation of the installation area

The FS63RTS Rugged Temperature Sensors are general purpose sensors that can be used embedded in concrete as well as on surfaces or other volumes.

The general recommendations for installation area preparation given for the FS62RSS sensors are applicable to the temperature sensor.

2.4.3 Installing the sensor

For a proper measurement of the Rugged Temperature Sensor, thermal contact between the sensor and the material to which the temperature is trying to be measured must be ensured.

Installation methods may vary a significantly form application to application. For example, sensors embedded in concrete should follow the same installation precautions as the embedded strain sensors; Sensors to be used in pair with surface mount sensors should be fixed to the wall, for example via anchors and cable ties.

Some examples are presented with pictures for illustration.

Fig. 2.34 Sensor to be embedded secured in place with plastic cable ties

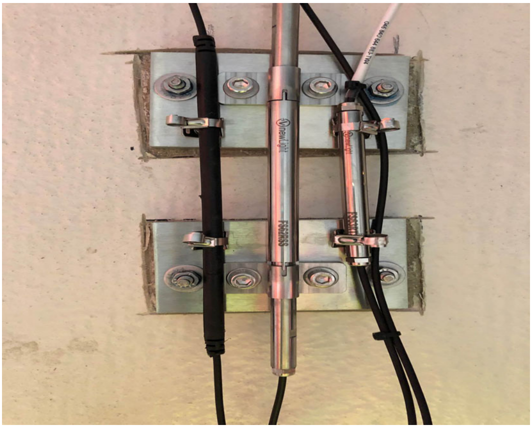

Fig. 2.35 Sensor surface mounted with metallic cable ties on specifically designed support

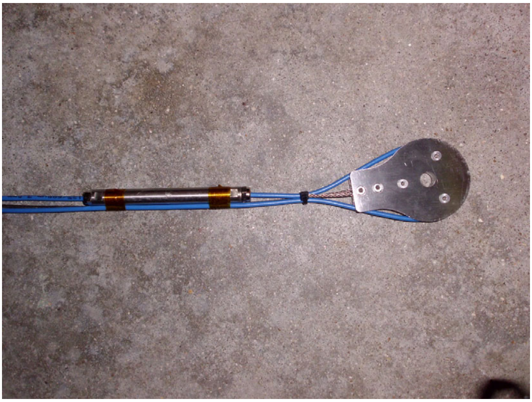

Fig. 2.36 Sensor surface mounted with tape to a steel cable prepared to be fixed along the length of a pillar, bellow seabed

2.4.4 Routing and protecting the cables

For cable routing and protection follow the presented instructions in “Routing and protecting the cables” sections:

- Sensors embedded in concrete: as in *section 2.2 “Embedded Strain Sensor” on page 8*;
- Sensors installed on surfaces: as in *section 2.3 “Surface Mount Strain Sensor” on page 20*.

2.4.5 Protecting the sensor

For sensor protection follow the presented instructions in the corresponding sections of the Strain sensors:

- Sensors embedded in concrete: as in *section 2.2.5 “Concreting” on page 19*;
- Sensors installed on surfaces: as in *section 2.3.6 “Protecting the sensor” on page 26*.

3 SENSOR CONFIGURATION

3.1 Sensors documentation

Calibrated HBK FiberSensing Sensors are delivered with a Calibration Sheet. Remaining sensors are delivered with a sensor Characteristic Sheet that contains important information for sensor configuration.

In the case sensors are delivered in arrays of pre-assembled sensors, a resume table with the relevant calibration information is provided in alternative.

Within the sensor's packing this installation instructions document is delivered in a printed version. Installation instructions can also be downloaded from HBK website (www.hbkworld.com).

3.2 Measurement computation

3.2.1 Temperature

The calculations that should be performed for converting a wavelength measurement into temperature are the shown in *Fig. 3.1*. The temperature value of a temperature sensor is given by a second order polynomial equation with coefficients obtained from the sensor calibration.

$$T = S_2(\lambda - \lambda_0)^2 + S_1(\lambda - \lambda_0) + S_0$$

Fig. 3.1 Temperature computation formula

Where

- T is the measured Temperature in ºC
- λ is the measured Bragg wavelength of the temperature sensor in nm
- λ_0 is the Bragg wavelength of the temperature sensor at reference temperature in nm
- S_0 is the zero order calibration factor (reference temperature) in ºC
- S_1 is the first order calibration factor in ºC/nm
- S_2 is the second order calibration factor in ºC/nm^2

When operating with catman® the values λ_0, S_0, S_1 and S_2 should be filled on the menu for temperature sensors configuration.

Measurement with distance effect correction

When measuring with sweeping laser based Optical Interrogators, such as the BraggMETER from HBK FiberSensing, there is an effect of the length of cabling between the interrogator and the sensor on the measured of the reflected measurement. Distance error becomes important for sensors that base their measurement on absolute wavelength values as it is the case of temperature sensors.

This effect is a constant shift in the wavelength measurement that depends on the actual sampling rate of the optical module and on the distance between the sensor and the interrogator. The shift on the measured wavelength is negligible for low acquisition rates or short distances, but becomes important for high sampling rates or long distances.

The sweeping laser emits a varying wavelength in time. The method for measuring the reflected wavelength from the fiber Bragg grating sensor identifies the wavelength that is being emitted at the time the reflected peak from the FBG is detected. As the acquisition rate grows, the effect of the delay caused by the distance the light needs to travel both ways gets higher and absolute wavelength gets less accurate. The same effect appears if the distances increase.

3.2.2 Strain

Strain sensors are not calibrated sensors. The characteristic sheet delivered with the sensor presents the sensor data for correct strain computation.

For the fiber Bragg grating strain sensors, wavelength variation including the effect of temperature is given by the equation as shown in *Fig. 3.2*.

$$\frac{(\lambda - \lambda_0)}{\lambda_0} = k \cdot \left(\varepsilon_{Load} + (TCS + CTE) \cdot (T - T_0)\right) \cdot 10^{-6}$$

Fig. 3.2 Wavelength variation of a strain FBG due to strain and temperature effects

Where

- λ is the measured Bragg wavelength of the strain sensor in nm
- λ_0 is the Bragg wavelength of the strain sensor at the reference instant in nm
- k is the strain k factor of the strain sensor, dimensionless
- E_{Load} is the mechanical strain applied to the structure in µm/m
- *TCS* is the temperature cross sensitivity of the strain sensor in (µm/m)/ºC
- *CTE* is the thermal expansion of the material of the specimen the strain sensor is attached to in (µm/m)/ºC
- T-T_0 ·is the temperature variation since the reference instant to the measurement instant in ºC

Measurement with no compensation

If no temperature compensation is required the strain computation can be done as shown in *Fig. 3.3*.

$$\varepsilon = \frac{(\lambda - \lambda_0)}{k \cdot \lambda_0} \cdot 10$$

Fig. 3.3 Strain without temperature compensation computation formula

Where

- ε is the measured strain in µm/m
- λ is the measured Bragg wavelength of the strain sensor in nm
- λ_0 is the Bragg wavelength of the strain sensor at the reference instant in nm
- k is the strain k factor of the strain sensor, dimensionless

Measurement with temperature compensation using a temperature sensor

Calculating compensated strain, in µm/m, using a temperature sensor is straightforward as the output of a temperature sensor is a temperature value in °C. The calculation is the depicted in *Fig. 3.4*.

$$\varepsilon_{Load} = \frac{(\lambda - \lambda_0)}{k \cdot \lambda_0} \cdot 10^6 - (TCS + CTE)(T - T_0)$$

Fig. 3.4 Strain computation with temperature compensation using a temperature sensor

Where

- ε_{Load} is the mechanical strain applied to the structure in µm/m
- λ is the measured Bragg wavelength of the strain sensor in nm
- λ_0 is the Bragg wavelength of the strain sensor at the reference instant in nm
- k is the strain k factor of the strain sensor, dimensionless
- TCS is the temperature cross sensitivity of the strain sensor in (µm/m)/°C
- CTE is the thermal expansion of the material of the specimen the strain sensor is attached to in (µm/m)/°C
- T is the measured temperature of the used temperature sensor in °C
- T_0 is the temperature from the sensor at the reference instant in °C

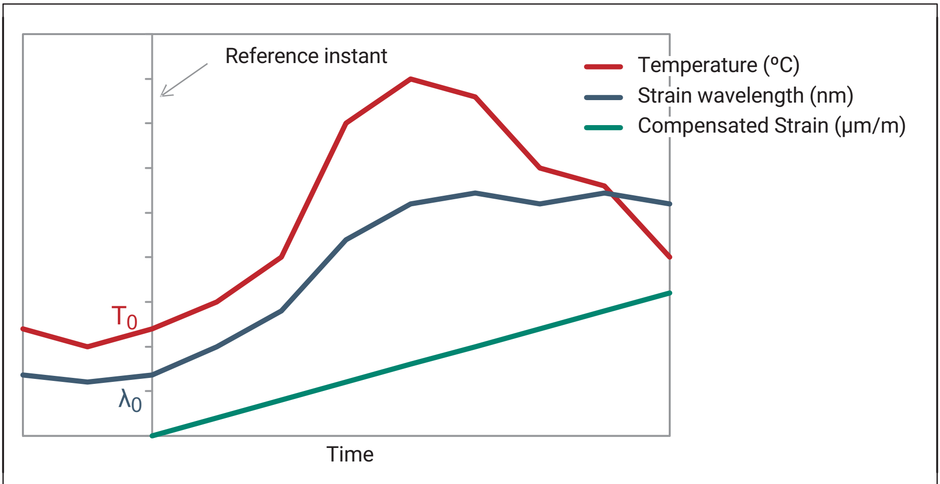

Fig. 3.5 *Reference instant for temperature compensated strain measurement when using a temperature sensor for compensation*

Measurement with temperature compensation using a compensation element

Strain measurement can also be correctly compensated using a compensation element based on FBG technology. Different approaches can be used:

- a temperature sensor without calibration certificate
- a strain sensor installed on a strain-free area of the same material
- a strain sensor installed on a strain-free material with a known CTE

The computation of strain can then be performed using the equation from *Fig. 3.6*.

$$\varepsilon_{Load} = \frac{\lambda - \lambda_0}{k \cdot \lambda_0} \cdot 10^6 - \frac{\lambda_{Tc} - \lambda_{0_{Tc}}}{\lambda_{0_{Tc}}} \frac{(TCS + CTE)}{TCF} \cdot 10$$

Fig. 3.6 *Strain computation with temperature compensation using an FBG compensation element*

Where

- ε_{Load} is the mechanical strain applied to the structure in µm/m
- λ is the measured Bragg wavelength of the strain sensor in nm
- λ_0 is the Bragg wavelength of the strain sensor at the reference instant in nm
- k is the strain k factor of the strain sensor, dimensionless
- λ_{TC} is the measured Bragg wavelength of the compensation element in nm

- λ_{0TC} is the Bragg wavelength of the compensation element at the reference instant in nm
- *TCS* is the temperature cross sensitivity of the strain sensor in (µm/m)/°C
- *CTE* is the thermal expansion of the material of the specimen the strain sensor is attached to in (µm/m)/°C
- *TCF* is the temperature compensation factor of the compensation element in (µm/m)/°C. For an uncalibrated temperature sensor the value is given on the sensor's characteristics sheet. For a strain sensor attached to a specific material TCF can be calculated as shown in *Fig. 3.7*.

$$TCF = (5.7 + k \cdot CTE_{TC})$$

Fig. 3.7 Temperature compensation factor computation

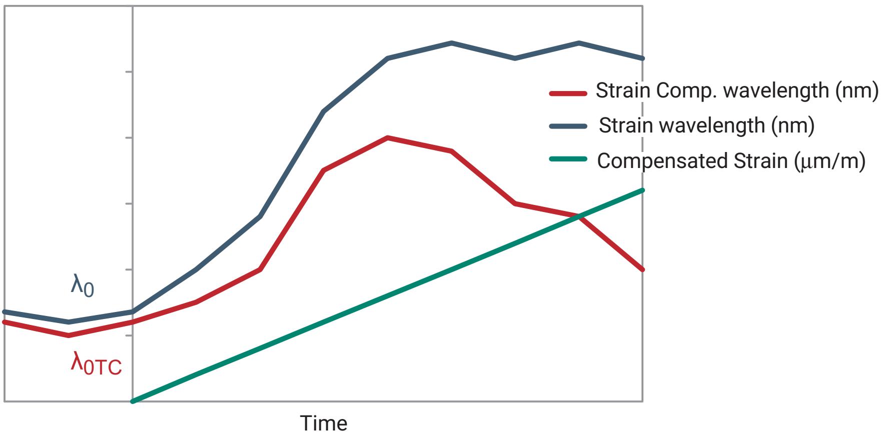

Fig. 3.8 Reference instant for temperature compensated strain measurement when using an FBG compensation element

Measurement with bending moment correction

When measuring on an element using a sensor that is far away from the attachment surface there may be an “error” on the measurement because the distance between the measuring point/alignment and the neutral axis is different to the distance between the installation surface and the neutral axis.

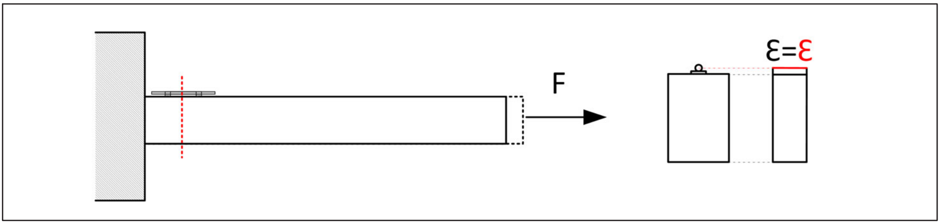

Fig. 3.9 *Strain on pure axial deformation*

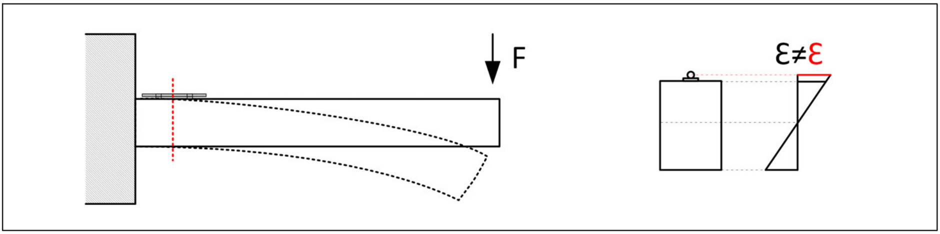

Fig. 3.10 *Strain on pure bending moment*

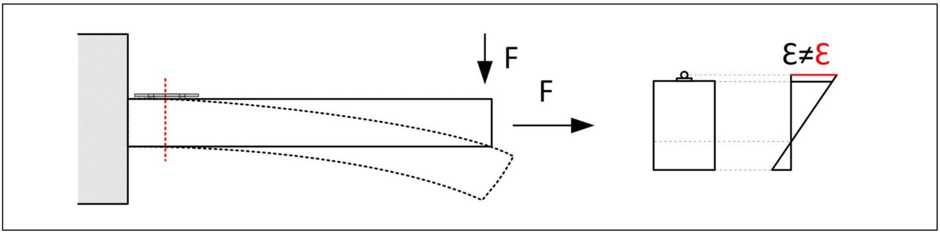

Fig. 3.11 *Strain on axial load and bending moment*

This becomes of high importance when the distance between the sensing element on the sensor to the attachment surface is relevant. This distance on the FS62RSS Rugged Strain Sensor to be Surface Mounted is 10 mm (h_2 on *Fig. 3.11*).

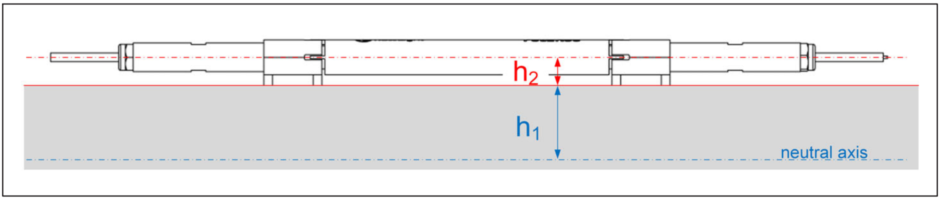

Fig. 3.12 Distance of the FBG to the mounting surface on the FS62RSS Surface Mount option

However, knowing the distance to the neutral axis (h_1) the measured strain from the sensor can be corrected into strain on the surface by a geometrical factor:

$$\varepsilon_{surface} = \frac{\lambda - \lambda_0}{k \cdot \lambda} \cdot \frac{h_1}{h_2 + h_1} \cdot 10$$

Fig. 3.13 Strain computation bending effect correction

Where

- $\varepsilon_{surface}$ is the mechanical strain on the measuring surface in µm/m
- λ is the measured Bragg wavelength of the strain sensor in nm
- λ_0 is the Bragg wavelength of the strain sensor at the reference instant in nm
- k is the strain k factor of the strain sensor, dimensionless
- h_1 is the distance from the measuring surface to the neutral axis in mm
- h_2 is the distance from the measuring surface to the FBG in mm (10 mm for the FS62RSS Surface Mount Option)

4 SENSOR MAINTENANCE

4.1 Sensor

4.1.1 Strain Sensor

Rugged Strain Sensors in their embedded version cannot be repaired after installation. If an embedded strain sensor is damaged during installation and before concreting, the solution is to completely replace the sensor. If damage occurs during concreting, although it is not expected that a strain sensor will be damaged under regular operating conditions, there is no possibility of replacing the sensor. More commonly, damage occurs to the connections rather than the sensor itself.

Rugged Strain Sensors in their surface mount version might be able to be checked and recalibrated at the factory. Since their attachment method is not permanent, a non-performing sensor can be removed carefully, as long as the cables can also be removed without being damaged. Surface mount sensors can be completely damaged beyond repair in cases of severe incidents (mechanical shock, extremely high temperatures, etc.). However, recalibration may be possible. Please contact HBK FiberSensing to discuss recalibration options. Note that recalibration performed by HBK FiberSensing may be subject to a fee.

4.1.2 Temperature Sensor

For temperature sensors, it might be possible to remove and reinstall the same sensor without causing damage, depending on the attachment method used. If embedded it is unlikely that the sensor can be removed without irreversible damage. However, if secured with polyimide tape or cable ties, on a surface it might be possible to retrieve the sensor without further damage.

Tip

Carefully remove any covering agents that may act as glue and damage the sensor during removal.

Temperature sensors can be completely damaged beyond repair in cases of severe incidents (mechanical shock, extremely high temperatures, etc.). However, recalibration may be necessary if the sensor has been subjected to temperatures higher than specified for short periods.

If it is possible to remove the installed sensor and an offset is observed, please contact HBK FiberSensing to discuss recalibration options. Note that recalibration performed by HBK FiberSensing may be subject to a fee.

4.2 Cables

If a cable is damaged during installation or use, a local repair might be possible. However, the feasibility of the repair depends on the location of the damage and the timing of occurrence. If the damage is too close to the sensor, there may not be enough cable length available to use the splicing tools, making the repair unfeasible. If the damage occurs during the concreting phase it is also impossible to repair.

When a repair is feasible and there is sufficient cable length, you can cut the cable to remove the damaged section and perform a splice on the fiber cable. If there isn't enough cable length, you will need to insert an extension and perform two splices. Please contact HBK FiberSensing for support with the splicing procedures.

When sensors are delivered in an array and a cable is damaged between two sensors, you will lose signals from all sensors past the damage. Cables can be repaired as described above.

Tip

If no repair is possible, it might be possible to recuperate some signals when connection redundancy exists. If the fiber can be interrogated from both ends, ensure that there is no light propagation at the location of the damage (by fully cutting the fiber connection) and insert a splitter between the optical connector of the interrogator and the two ends of the sensor array.

Tip

For embedded try to keep as little connections as possible inside the concrete.

4.3 Connectors

If a connector is damaged, it can be replaced either by performing a local splice or by returning the sensor for reconnection. Note that repairs performed by HBK FiberSensing may be subject to a fee.

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