MS-03 Installation procedure

Introduction

This document aims to describe the installation procedures for the deployment of the MS-03 strain sensor on a surface of a monitored object. MS-03 can be as well embedded into the concrete – after being correctly mounted it is possible to grout or spray the sensor with the concrete.

Installation of the sensor brackets depends on the installation possibilities and surface material type. For achieving the most stable and long-term bond between the monitored structure and the MS-03 sensor brackets, we recommend selecting the installation methods in order as Welding → Screwing → Gluing.

Installation requirements

Instruments & Tools

- MS-03 mounting brackets
- Two spanner keys, size 10
- FBG interrogator with suitable bandwidth
- Standard welding equipment and accessories
- Personal Protective Equipment
- Optional: High Strength Thread-Locking Adhesive Loctite 2701
- Optional: Additional adhesives for combined installation (mechanical-chemical)

note: other standard tools, accessories, and equipment may be required for the installation but there not the subject of this guide.

Installation time

Typical installation time for MS-03 sensor: **between 5-10min** (surface preparation is not considered).

Installation sequence

Time indicates the estimated time efforts of the installation (in detail in the next chapters).

(1) Anchoring distance [<1 minute]

(2) Surface preparation [5 minutes] [1]

(3) Mounting of brackets [2 minutes]

I. Welding
II. Mechanical (Screwing)
III. Chemical (Gluing)

(4) Mounting of MS-03 into brackets [2 minutes]

(5) Setting up pre-strain [2 minutes] [2]

[1] Time for completing highly depends on the surface of the monitored object.

[2] Requires sensor to be connected to the interrogator.

(1) Anchoring distance and gauge length

The MS-03 is a short gauge strain sensor with a fixed gauge length. The gauge length of the sensor is near or equal to his anchoring distance, for more details see Figure 1. The position of the sensor's mounting brackets during installation is defined by the anchoring distance which by ideal conditions is 110mm.

Note: Please, refer to the product drawing for more detailed information about the dimensions and mounting bracket possibilities.

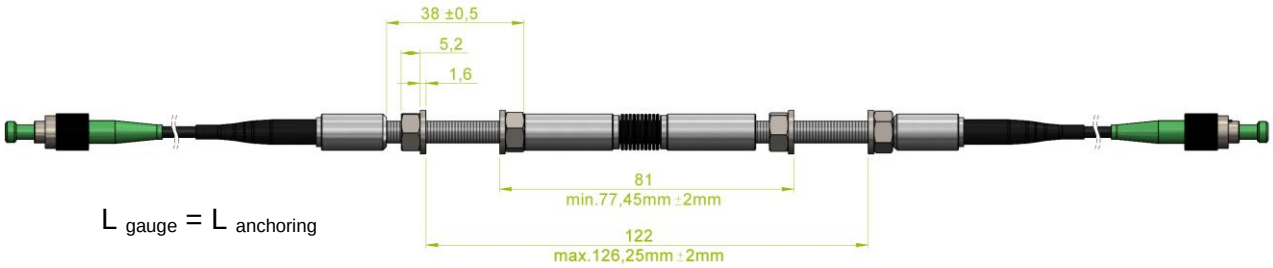

Figure 1. Schematic representation of the SC-01 gauge and anchoring length.

(2) Surface preparation

Regardless of the installation method, it is recommended to properly treat the surface to which the brackets should be installed. This process includes mechanical cleaning of the surface using abrasive materials and removal of any protective paint, rust, debris, or similar imperfection from the surface. It's only necessary to clean areas where the mounting brackets will be installed.

Chemical treatment of the surface is recommended to happen no longer than 20min before the installation to avoid the creation of oxide layers on the treated surface.

Recommended cleaning solvents (not included inside the packaging):

- Loctite 7061
- Loctite 7063

(3) Installation of the mounting brackets

The MBM-03 brackets series are made from stainless steel 304 and therefore they are possible to be welded down to a steel surface, mechanically mounted (screwed), or even bonded to a surface using an appropriate adhesive. Welding is recommended for long-term deployment.

Regardless of the installation method, several critical conditions have to be fulfilled to have the mounting brackets reliable installed on the surface:

(1) The anchoring distance represents the distance from center to center of a pair of MBM-03 mounting brackets used for the installation of one MS-03 sensor (see Figure 1).
(2) The mounting brackets have to be installed in one axis with each other and perpendicular to the measured surface.
(3) Both brackets have to be in the same height level, otherwise, possible geometrical errors can occur during the measurement.

Direct (Indirect) welding method

Direct welding[3] of the mounting brackets is recommended for long-term applications since it creates a stable bond between the brackets and the monitored surface. The anchoring distance has to be respected during welding to allow pre-strain adjustment. The sequential installation steps are shown in Figure 2.

During the installation using the indirect method, mounting bracket support is welded down instead of the bracket itself. The support is usually represented by a threaded stud and requires less space and energy during the installation compared to direct welding. This results in a fast, minimal surface intrusion installation method.

During any installation method, it is mandatory to follow up the anchoring distance to adjust the pre-strain of the sensor. A mismatch in the anchoring distance could result in possible issues and not meeting the required measurement range.

Figure.2 shows the surface preparation for both welding methods. The green color represents a protective layer that needs to be removed.

[3] Welding using MMA/MIG/MAG/TIG/LASER technology or electrode technology is applicable for this method.

The areas in the axis of the sensor area used for the actual welding of the brackets – min. 30x30mm with a distance between each other center-to-center equal to 110mm. The additional area shown in Figure 2 is not mandatory but indicates the necessity of the ground connection during welding.

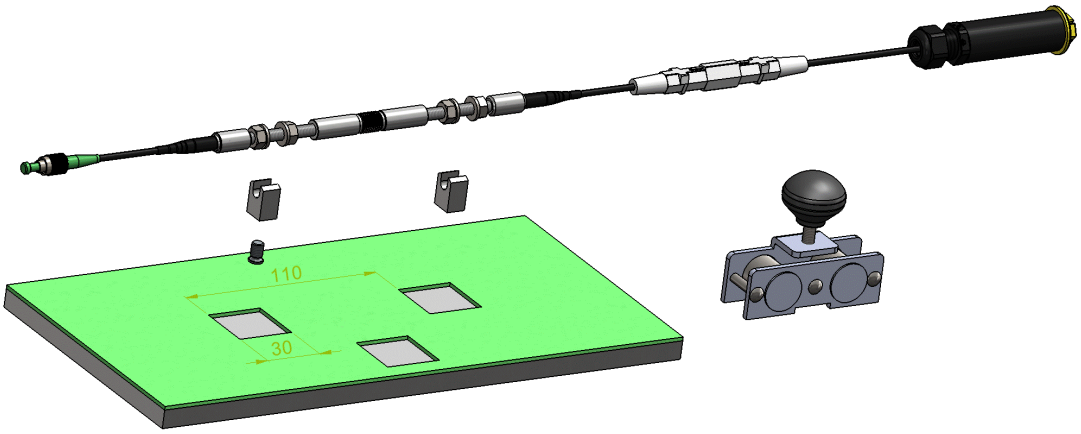

Figure 2. Installation of the mounting brackets MBM-03 M6 version during direct welding and Indirect method

Figure. 3 shows a collection of real-world installation examples of the indirect welding method. The figure shows; surface preparation; stud welding process; mounting bracket with the recovered surface area.

Figure 3. Real-world installation example of indirect welding method.

Mechanical installation - surface (screwing)

Mechanical installation is based on using four standard M4 metric screws (two at each side). These screws are supplied with the mounting brackets MBM-03 XY version[4]. This method applies to concrete, brick walls, or even metal structure if welding is prohibited.

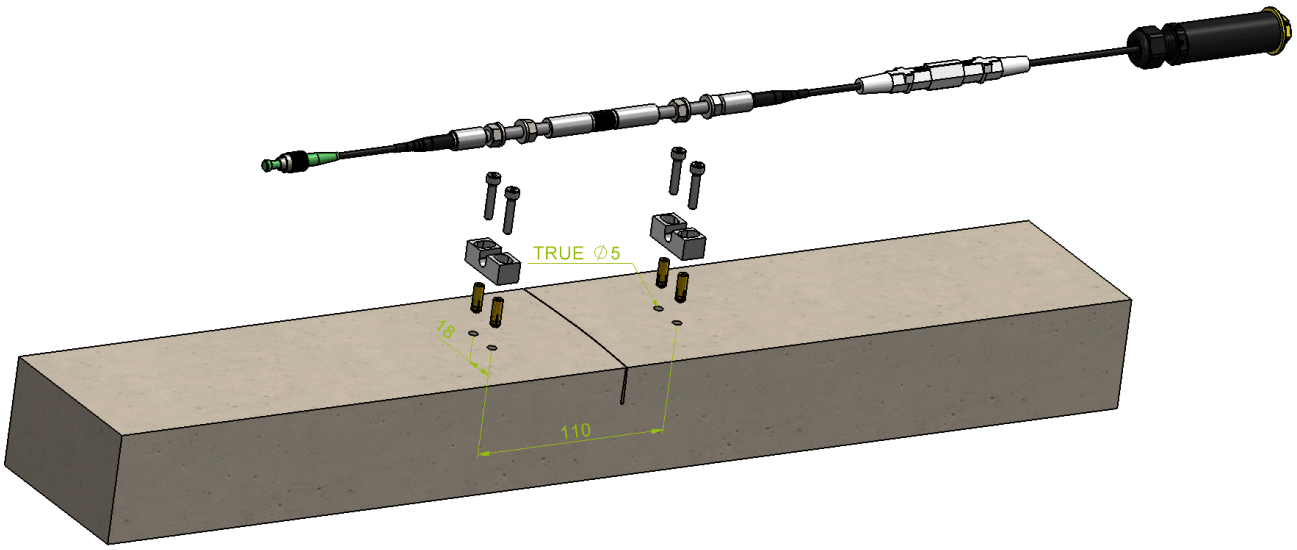

Figure 4. Mechanical installation for concrete crack monitoring

The XY version of the mounting bracket features position adjustment in the X and Y axis within 3mm to compensate for possible misalignments during installation.

Mechanical installation – steel strand (screwing)

Similar to the surface installation, the mounting brackets are fastened around the steel strand using four standard M4 metric screws (two for each bracket). These screws are supplied with brackets MBM-03 Steel strand version[5].

Regardless of the installation method, during the installation of the mounting brackets, it is mandatory to follow up the anchoring distance as much as possible. However, due to installation difficulties, the final distance can differ and therefore the sensors have an adjustable fixation range of 38mm. The allowed installation tolerances can be calculated using the example below.

[4] Suitable thread adhesive (Loctite 2701) or secure washers can always improve the stability of this installation method. The dowels are not supplied with the bolts.

[5] Suitable thread adhesive (Loctite 2701) or secure washers can always improve the stability of this installation method. The dowels are not supplied with the bolts.

For example:

- The mounting bracket MBM-03 steel strand version has a width of 15mm.
- Anchoring distance tolerance: minimum 92,45mm (77,45+15) and maximum 111,25mm (126,25-15)

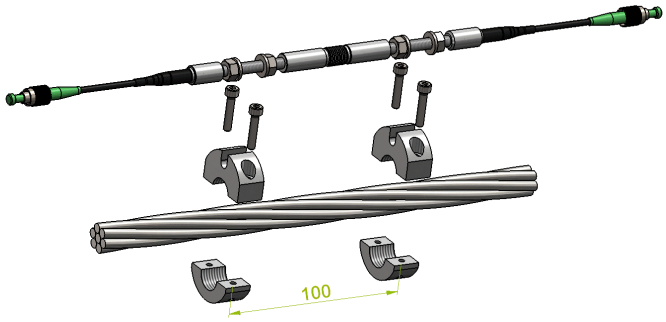

Figure 5. Mechanical installation on steel strand

Chemical installation (glue bonding)

Chemical installation is based on using an adhesive that bonds the bracket with the measured surface. The glue is not supplied with the sensor.

The selection of suitable adhesives highly depends on the material of the surface[6] and environmental conditions. Special curing procedures such as elevated temperature, or air humidity can be mandatory for a successful curing process.

All types of MBM-03 brackets are compatible with this method.

(4) Mounting of MS-03 into brackets

Before placing the MS-03 into the installed brackets (Figure 6), slide the washers and nuts to the sides. There has to be one nut and a washer on each side of a bracket.

[6] As an example, for steel surface a so-called liquid metal can be used, Loctite 3450. For concrete surfaces, EPO-TEK® 730 is possible to be used.

Tip: Place the sensor into the brackets in a way that one bracket is close to the end of the threaded part, around 1cm from the edge (Figure 6, second step). This will make the pre-straining process more convenient Secure this position by using two spanner keys size 10.

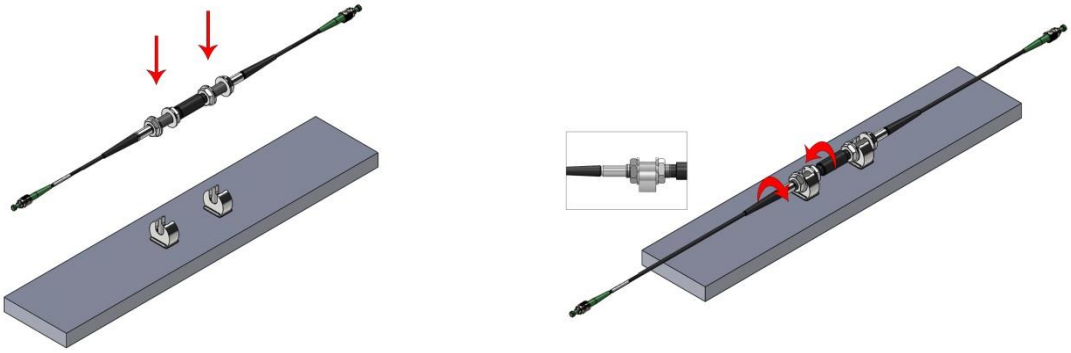

Figure 6: Mounting of MS-03 into brackets.

(5) Setting up pre-strain

The MS-03 doesn't have an in-built pre-strain and therefore it is necessary to pre-strain this sensor during installation to detect compression. This is performed already with the sensor positioned inside the mounting brackets and therefore, it's mandatory to have the mounting brackets in place before the pre-strain process.

For example, if the desired measuring range of the MS-03 should be ±2000μƐ, it is required to pre-strain the sensor for no less than 4800pm (4,8nm). The necessary wavelength shift can be calculated using equation (1).

$$^{7}\lambda_{shift} = \varepsilon_{max} \times 1{,}2 \qquad (1)$$

where, λ_{shift} is the calculated wavelength and ε_{max} is the maximum assumed strain.

[7] The conversion constant between wavelength shift and strain change can slightly differ due to sensors properties. Please, refer to the datasheet for a more accurate value.

After securing one side of the MS-03, the pre-straining of the sensor can be done as shown in Figure 7. Use a spanner key size 10 and rotate the inner nut in a clockwise direction to adjust the pre-strain to the required value. Afterward, secure the sensor in place by using two spanner keys size 10, as shown in Figure 7.

It is recommended to use a thread locking adhesive like Loctite 2701.

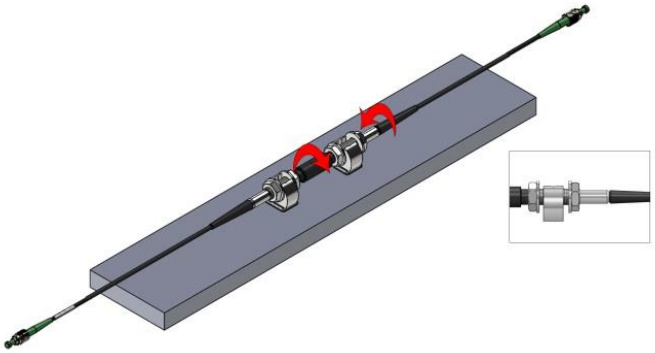

Figure 7: Pre-straining the sensor.

For more information contact our sales team at sales@sylex.sk

* Specifications are subject to change without notice