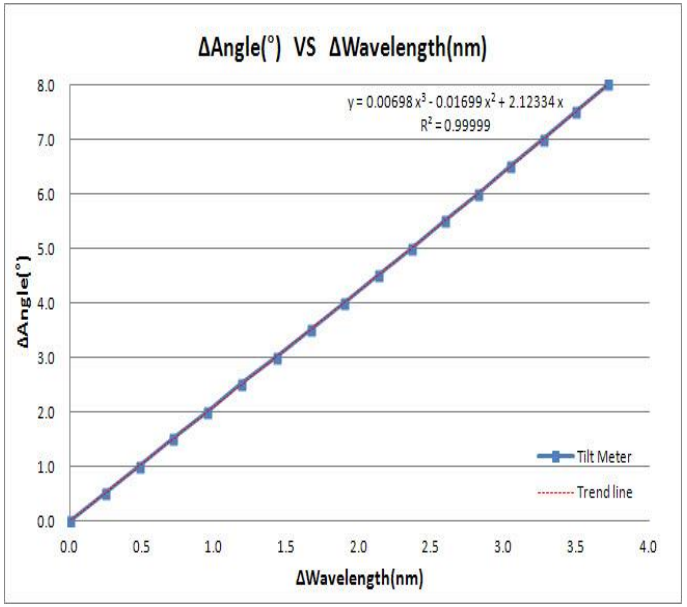
4.6 FBG Tilt-meter - Designation of Excellent R&D Revolutionary Product

"USA, EU, China, Japan, Canada patents" registered

- ✓ Long-term measurements for the angle variation of structures
- ✓ Measurements for the angle variation of tunnels, dams and road surface
- ✓ Measurements for the angle variation of structures during construction or after completion of construction
- ✓ Measurements for the angular variation of adjacent structures due to the construction of downtown
- ✓ Safety evaluation on adjacent structures when works excavation or fill-up bank
- ✓ Built-in FBG sensor for temperature compensation

Model	FBG-TI-310
Measurement Range	± 3 / ±10 deg (Depending on user's demand)
FWHM(-3 dB point)	≦ 0.3 nm
Resolution(%.F.S)	± 0.05
Accuracy(%.F.S)	± 0.3, 0.5, 1 (Depending on user's demand)
React time(sec)	≦ 20
Reflectivity(%)	≧ 70
Wavelength(nm)	1,511 ~ 1,590
Operating temperature(℃)	-20 ~ 80
Dimension(mm)	87 X 41 X 93
Sensitivity(pm/°)	≧ 450 (Depending on user's demand)
Weight(kg)	≦ 1.2

Compared with other companies of which FBG Tilt-meters are operated broad bandwidth in the range of wavelength by using "TWO FBG" sensors, our sensors can be operated at half of that because they use only "ONE FBG" for angle measurement and have high accuracy. Therefore Interrogator cost can be reduced.



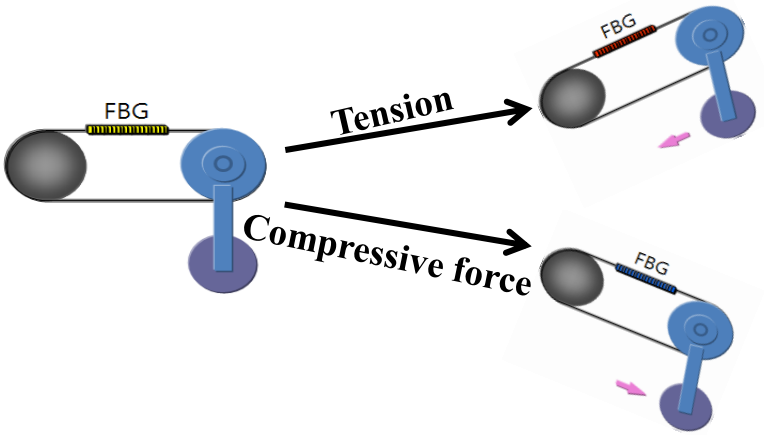
Wavelength set division

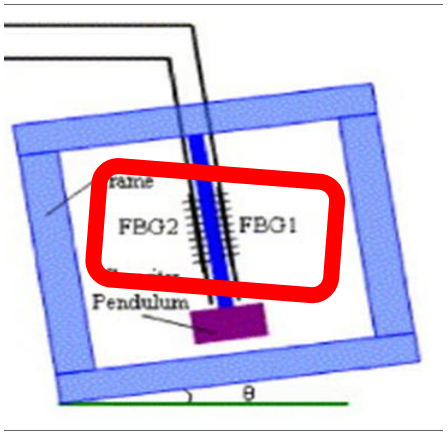
SET-A		SET-B	
No.	Operating Wavelength range (nm)	No.	Operating Wavelength range (nm)
1	1511.1~1516.2	1	1514.1~1519.2
2	1517.1~1522.2	2	1520.1~1525.2
3	1523.1~1528.2	3	1526.1~1531.2
4	1529.1~1534.2	4	1532.1~1537.2
5	1535.1~1540.2	5	1538.1~1543.2
6	1541.1~1546.2	6	1544.1~1549.2
7	1547.1~1552.2	7	1550.1~1555.2
8	1553.1~1558.2	8	1556.1~1561.2
9	1559.1~1564.2	9	1562.1~1567.2
10	1565.1~1570.2	10	1568.1~1573.2
11	1571.1~1576.2	11	1574.1~1579.2
12	1577.1~1582.2	12	1580.1~1585.2
13	1583.1~1588.2		

- 13 kinds of Set-A, 12 kinds of Set-B.
- Can make a total of 25 kinds from FBG tilt-meter.

4.6 FBG Tilt-meter

General Characteristics : FBG KOREA sensor vs Other sensor





FBG KOREA Sensor

- Size/Weight : 10cm/1kg or under
  → Suitable for all kinds of structures according to the effective space use
- Only **One sensor** → Save interrogator cost
- Tilt measurement method (Directly)
  : **Measure tension change of FBG sensor**
  → **High accuracy**

Other Sensor

- Size/Weight : 20cm/2kg and over
  → Unsuitable for some structures due to excessive space use
- Two sensors → Demand double interrogator cost
- Tilt measurement method (Indirectly)
  : Measure stress changes of a metal like a weight
  → Large measurement error (Hysteresis in metal)

FBG KOREA Tiltmeter Advantages

- ✓ No hysteresis of metal
- ✓ Built-in FBG sensor for temperature compensation
- ✓ Simultaneously measure an angle and ambient temperature
- ✓ Save measuring cost of by using a single FBG

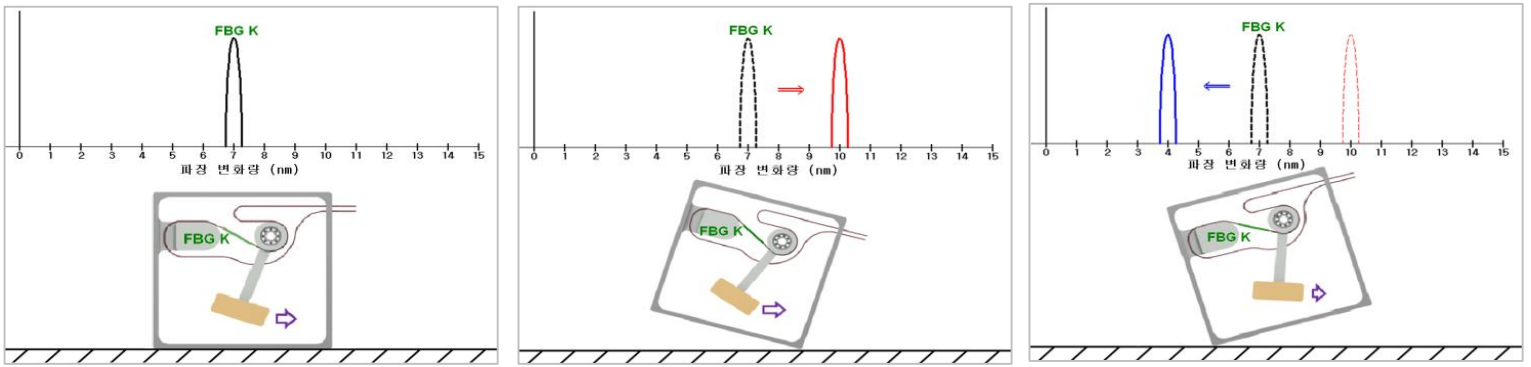
4.6 FBG Tilt-meter

Measurement principle of FBG Tiltmeter : FBG KOREA sensor vs Other sensor

FBG KOREA Sensor

- High accuracy and reliability without hysteresis in metal by measuring tilt with the FBG sensor
- Reduce the cost by using only one sensor

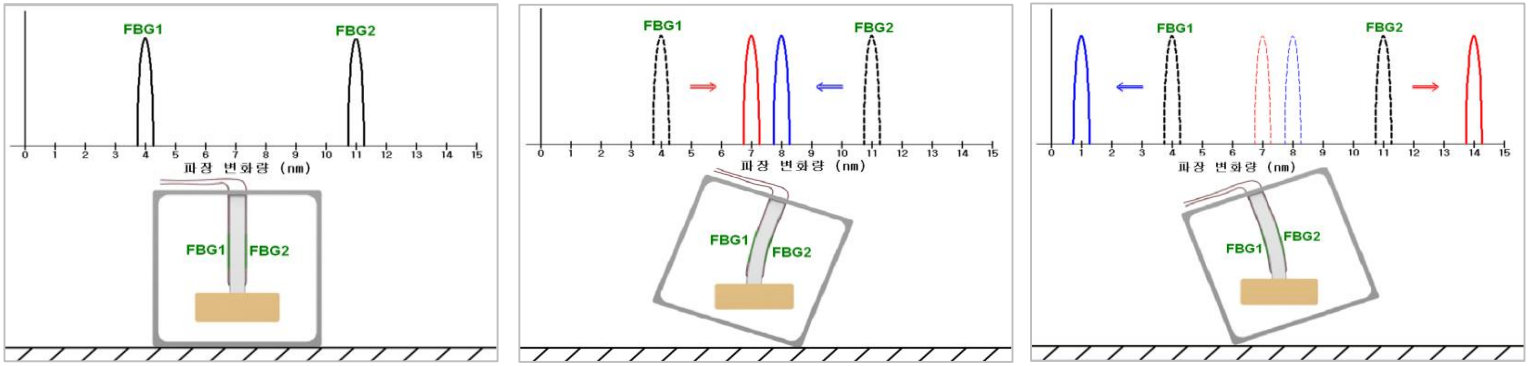
degree 0° | degree 3° | degree -3°



★ **The size of FBG sensor can get smaller at the same measurement resolution and the sensor is available in narrow areas.**

Other Sensor

- Reduce the accuracy by hysteresis in metal
- Demand double bandwidth in the range of wavelength for interrogators by using two sensors and need more expenses



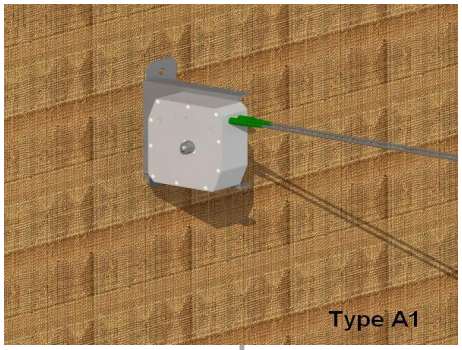
4.6 FBG Tilt-meter

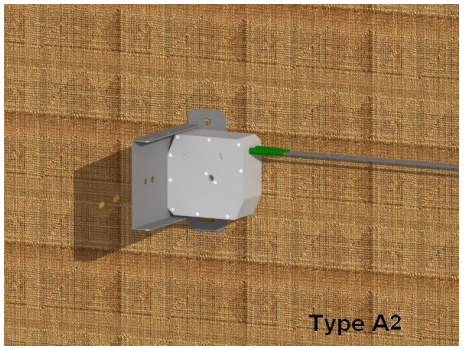
Installation Type of FBG Tiltmeter

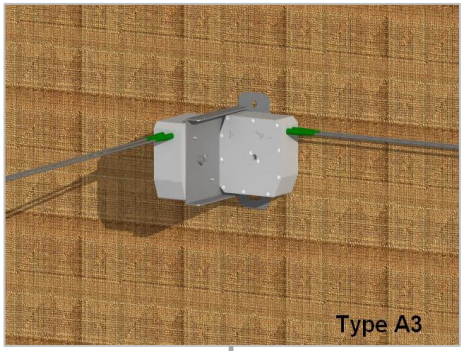
√ **Possible to install sensors with jigs according to the combination of two devices and the installation place**

- **Type A – Installed on the wall**
  - **Type A1 – Combination with a jig side by side**
  - **Type A2 – Combination with a crossed jig**
  - **Type A3 – Combination of one jig and two sensors (Type A1 + Type A2)**
- **Type B – installed on the bottom**

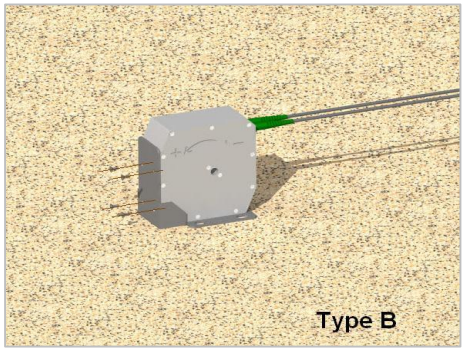
◆ **Refer to installation guide for each type on next pages.**







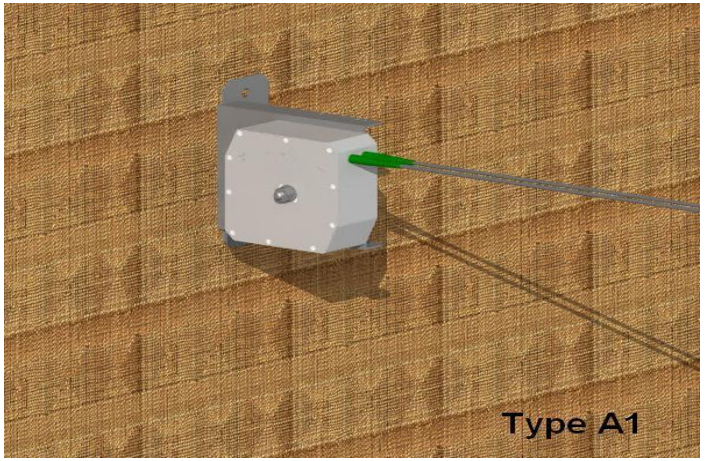
[On the Wall]



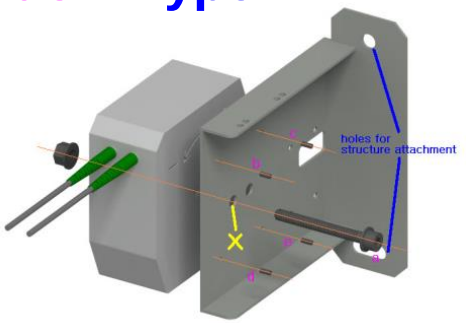
[On the Bottom]

4.6 FBG Tilt-meter

FBG-TI-310 Installation Guide - Type A1

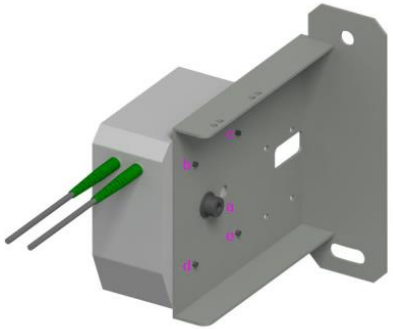


①



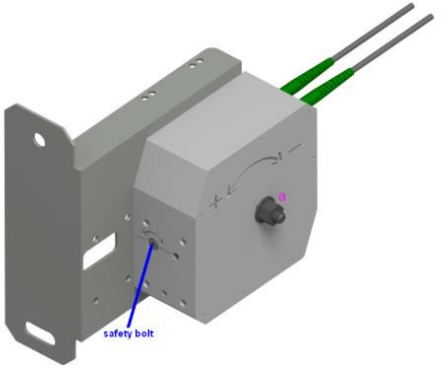
▪ Make installation the jig in the structure as fixing the holes marked in blue .
▪ Place the sensor alongside the installed jig and attach it to the jig with the bolt “a” through the hole “X”.

②



▪ Push and tighten the four small bolts(“b” to “e”) against the surface of the sensor body.
√ Note : No need to tighten the bolts up very strongly.

③



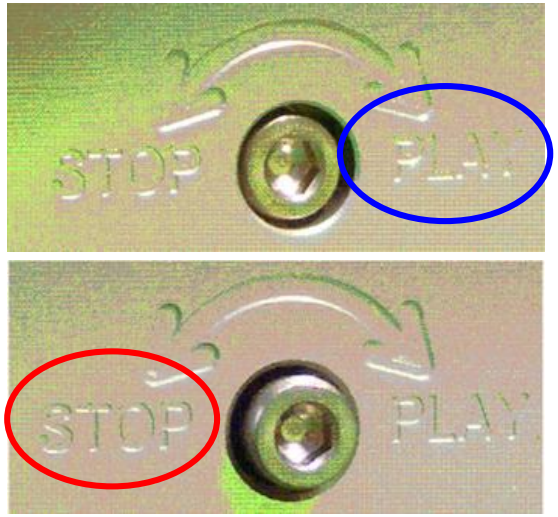
▪ Turn the safety bolt in the “play” direction until it feels tight.
√ Refer to the setting guide for safety bolts on the next page.

4.6 FBG Tilt-meter

◆ Setting the Safety Bolt

▪ In order to use FBG Tilt-meter correctly,
turn the safety bolt in the **"play"** direction until it feels tight just after you combine the tilt-meter with the jig installed on the structure.

▪ Do not force to turn the bolt in each direction too tightly so as not to wear down the rubber o-ring put on the bolt inside.



Play: for operating the sensor ;
(The safety bolt goes into the hole.)

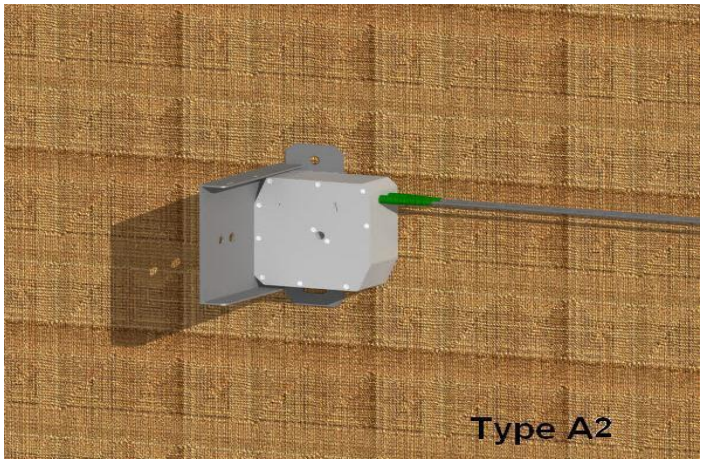
Stop: for moving or keeping the sensor ;
(The safety bolt comes out of the hole.)

√ **Note**

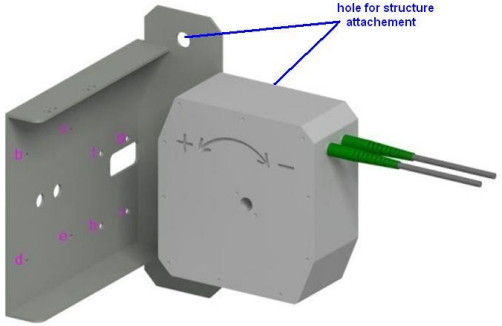
- **After use or while moving, turn the safety bolt in the "stop" direction until it feels tight to restore the initial state.**
- **If don't, the sensor would be damaged and spill some liquid from the inside.**

4.6 FBG Tilt-meter

FBG-TI-310 Installation Guide - Type A2

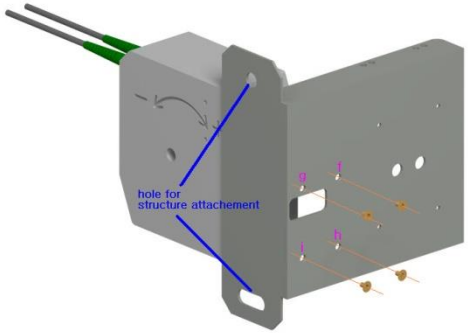


①



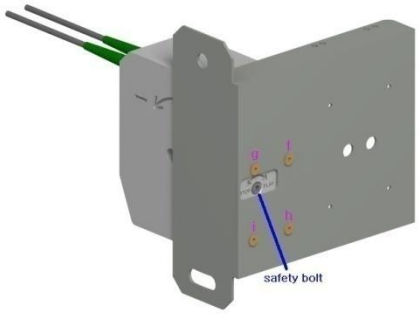
▪ Make installation the jig in the structure as fixing the holes marked in blue .
▪ Combine the sensor crossed with the installed jig.

②



▪ Push and tighten the four small bolts(“f” to “i”) against the surface of the sensor body.
√ Note : No need to tighten the bolts up very strongly.

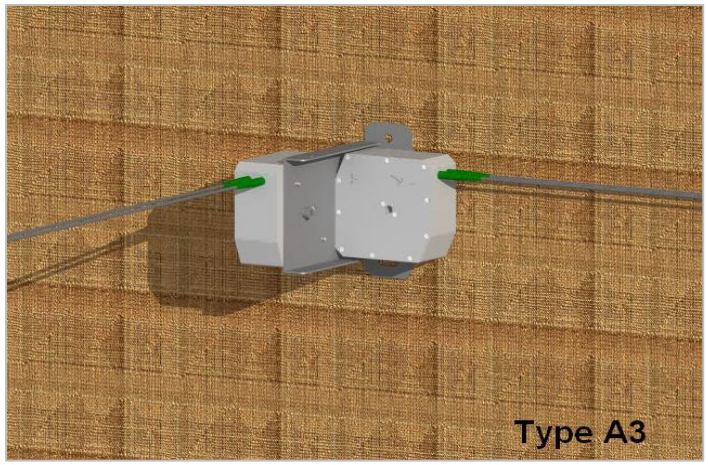
③

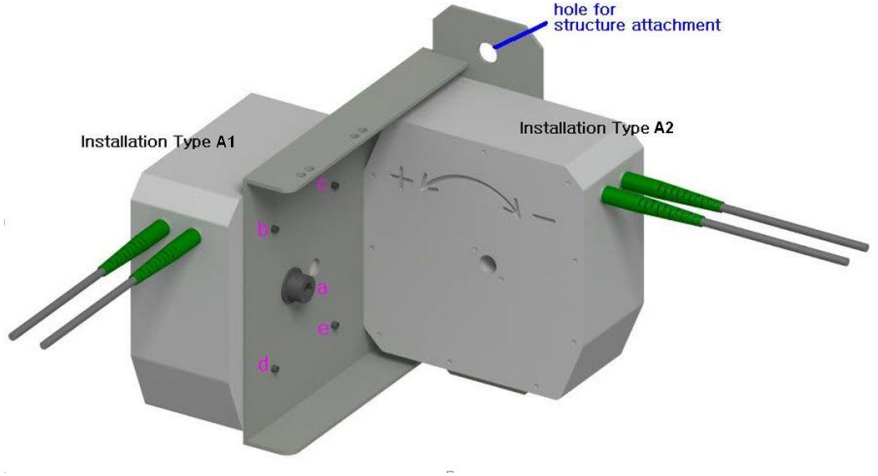


▪ Turn the safety bolt in the “play” direction until it feels tight.
√ Refer to the setting guide for safety bolts on the previous page.

4.6 FBG Tilt-meter

FBG-TI-310 Installation Guide - Type A3 (A1+A2)



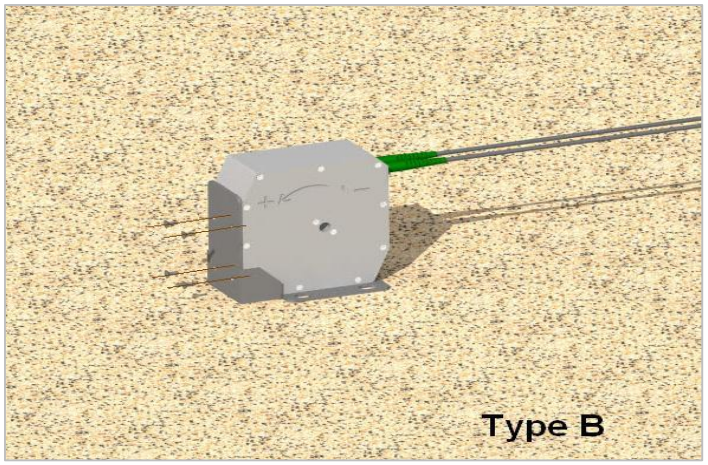


- Make installation the jig in the structure as fixing the holes marked in blue .
- Attach two sensors with one installed jig according to the installation ways of type A1 and type A2.
- Turn the safety bolt in the “play” direction until it feels tight.

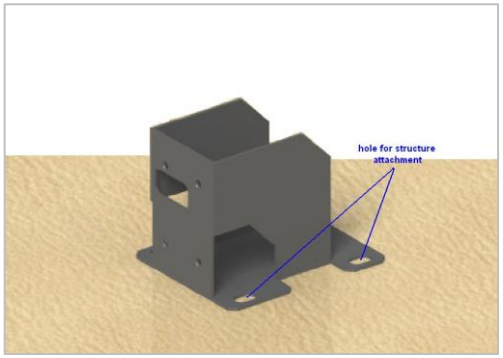
√ Refer to the setting guide for safety bolts on the previous page.

4.6 FBG Tilt-meter

FBG-TI-310 Installation Guide - Type B

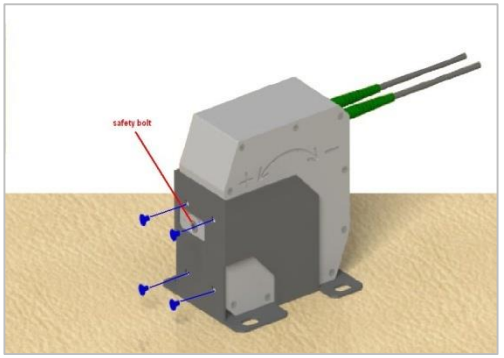


①



▪ Make installation the jig on the bottom of the structure as fixing the holes marked in blue .

②



▪ Push and tighten the four small bolts against the surface of the sensor body.
▪ Turn the safety bolt in the “play” direction until it feels tight.
√ Refer to the setting guide for safety bolts on the previous page.