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SENSOR AND INSTALLATION METHOD FOR LONG-TERM MEASUREMENT OF AVERAGE PHYSICAL QUANTITIES

FIELD OF THE INVENTION

This invention relates to a sensor and an installation method for long-term measurement of average physical quantities.

DESCRIPTION OF THE PRIOR ART

Currently, there are various sensors such as electrical strain gauges, vibrating wire strain gauges and fibre optic sensors for measurement of physical quantities such as stress and pressure, etc.

The gauge length of these sensors ranges from several millimeters to about 100 millimeters. They can measure the physical quantities over the gauge length. However, they can't directly measure average physical quantities over a length which is longer than their gauges.

These sensors need to fix on an object and measure the physical quantities of the object. The fixing means shall transfer the physical quantities of the object to the sensor without distortion of the physical quantities.

However, the fixing means such as adhesive bonding, welding and mechanical fastening may over the years deteriorate the transfer accuracy of the physical quantities between the object and the sensor resulting error of measurement of the physical quantities.

SUMMARY OF THE INVENTION

The present invention provides a sensor and installation method of the sensor on an object to measure the physical quantities over a limited gauge length to the average physical quantities over a longer gauge length. The invention also provides means whereby the sensor is suitable for long-term measurement of the physical quantities.



BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a sensor and installation method embodying the present invention.

Figure 2 is a perspective view of the sensor assembly showing a preferred embodiment of the invention.

Figure 3 is a perspective view showing a preferred fixing means of the sensor assembly.

Figure 4 is a perspective view showing a preferred fixing means of the carrier of the sensor assembly.

Figure 5 is a perspective view showing a preferred fixing means of the sensor assembly directly on the object to be measured.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sensor and installation method, as shown in Figure 1, comprise an object 1, a carrier 2, a fixing means 3, a sensor assembly 4, a fixing means 5 and a sensor reading unit 6.

The object 1 is to be measured for its physical quantities such as strain, displacement, stress and pressure, etc. The object 1 can be aircraft structures, concrete or soil structures of buildings and infrastructures, marine structures, and pipelines, etc.

The carrier 2 is fixed on the object 1 via the fixing means 3. The carrier 2 ranges preferably several hundred millimeters in length to multiple meters. The carrier 2 can be in any shapes, which preferably are strip, tube or circular plate.

The fixing means 3 is to transfer the physical quantities of the object 1 to the carrier 2. The fixing means 3 can be adhesive bonding, welding and mechanical fastening, etc.

The sensor assembly 4 connecting to its reading unit 6 is fixed on the carrier 2 via the fixing means 5. The sensor assembly has gauge length ranging from few millimeters to about 100 millimeters.

The sensor assembly 4 can be electrical strain gauge, vibrating wire strain gauge, piezo sensor and fibre optic sensor (fibre Bragg grating, Fabry-Perot sensors, etc.)

The sensor assembly 4 is in the same shape of the carrier 2.

The fixing means 5 is to transfer the physical quantities of the carrier 2 to the sensor assembly 4. The fixing means 5 can be adhesive bonding, welding and mechanical fastening, etc.

The sensor assembly 4, as shown in Figure 2, comprises one sensing element 7A or more sensing elements 7B. The sensing elements 7A and 7B measure the physical quantities over their gauge lengths.

The fixing means 5, as shown in Figure 3, is to provide fixing of the carrier 2 to the sensor assembly 4 at two positions 5A and 5B. This is to convert point measurement of the physical quantities of the sensor elements 7A or 7B to average measurement of the physical quantities between the fixing positions 5A and 5B. The distance between the fixing positions 5A and 5B ranges few hundred millimeters up to multiple meters. When the fixing means 5 is adhesive bonding, bonding of the sensing elements 7A or 7B directly on the carrier 2 experience problem of adhesive creep. When the sensor assembly 4 is bonded at the fixing positions 5A and 5B, the adhesive creep at 5A and 5B affect the distance between 5A and 5B, which is much longer than the gauge length of the sensing elements 7A and 7B resulting in less deterioration of measurement accuracy of the physical quantities transferred from the carrier 2.

The fixing means 3, as shown in figure 4, is to provide fixing of the object 1 to the carrier 2 at the fixing positions 3A and 3B. This is to measure average physical quantities of the object 1 between the fixing positions 3A and 3B.

Figure 5 shows omission of the carrier 2 and direct fixing of the sensor assembly 4 to the object 1 at the fixing positions 3A and 3B.

The carrier 2 can be in any shapes which are preferably tubular shape whereby the sensor assembly 4 is fixed inside of the tube; or which are preferably solid bar whereby the sensor assembly 4 is fixed on the surface of the bar as shown in Figure 1.

26/03/2007

The carrier 2 can be in any materials, which are preferably fibre reinforced polymer, plastic and metal, etc.

The carrier 2 can be a rigid or flexible tube when pre-tension needs to apply on the sensor assembly 4. A flexible helical tube can be used to provide the pre-tension of the sensor assembly 4 when the tube is in its straight position. When the flexible helical tube is in its spooling position, the pre-tension of the sensor assemble 4 is removed.

Claims

1. A sensor comprising:
 - a carrier having two fixing positions, the carrier being couplable to an object at the two fixing positions; and
 - an optical fibre having at least one sensing element, the optical fibre being coupled to the carrier by two fixing means, each of the two fixing means being substantially proximal to one of the two fixing positions,
 - wherein the carrier conveys deformational displacement of the object between the two fixing positions to a portion of the optical fibre between the two fixing means, and the at least one sensing element has an optical property that is reactive to the deformational displacement conveyed to the portion of the optical fibre between the two fixing means, and
 - wherein when the carrier is coupled to the object, the deformational displacement of the object between the two fixing positions is measurable by monitoring changes in the optical property of the at least one sensing element, the changes in the optical property of the at least one sensing element being substantially representative of the deformational displacement of the object between the two fixing positions.
2. The sensor as in claim 1, wherein each of the at least one sensing element comprises a fibre optic sensor.
3. The sensor as in claim 2, wherein the fibre optic sensor being one of fibre Bragg grating sensor and Fabry-Perot sensor.
4. The sensor as in any of claims 1 to 3, the carrier being a solid bar.
5. The sensor as in any of claims 1 to 3, the carrier being a rigid tube with the at least one sensing element disposed therewithin.

6. The sensor as in any of claims 1 to 3, the carrier being a flexible tube with the at least one sensing element disposed therewithin.
7. The sensor as in any of claims 1 to 6, each of the two fixing means being adjacent one of the two fixing positions.
8. A sensor installation method comprising the steps of:
 - providing a sensor comprising:
 - a carrier having two fixing positions; and
 - an optical fibre having at least one sensing element, the optical fibre being coupled to the carrier by two fixing means, each of the two fixing means being substantially proximal to one of the two fixing positions, and
 - coupling the carrier of the sensor to an object at the two fixing positions, wherein the carrier conveys deformational displacement of the object between the two fixing positions to a portion of the optical fibre extending between the two fixing means, and the at least one sensing element has an optical property that is reactive to the deformational displacement conveyed to the portion of the optical fibre between the two fixing means, and
 - wherein the deformational displacement of the object between the two fixing positions is measurable by monitoring changes in the optical property of the at least one sensing element, the changes in the optical property of the at least one sensing element being substantially representative of the deformational displacement of the object between the two fixing positions.
9. The sensor installation method as in claim 8, wherein each of the at least one sensing element comprises a fibre optic sensor.
10. The sensor installation method as in claim 9, wherein the fibre optic sensor being one of fibre Bragg grating sensor and Fabry-Perot sensor.

11. The sensor installation method as in any of claims 8 to 10, the carrier being a solid bar.
12. The sensor installation method as in any of claims 8 to 10, the carrier being a rigid tube with the at least one sensing element disposed therewithin.
13. The sensor installation method as in any of claims 8 to 10, the carrier being a flexible tube with the at least one sensing element disposed therewithin.
14. The sensor installation method as in any of claims 8 to 13, each of the two fixing means being adjacent one of the two fixing positions.
15. A sensor comprising:
 - a carrier having two fixing positions, the carrier being couplable to an object at the two fixing positions; and
 - an optical fibre having at least one sensing element, the optical fibre being coupled to the carrier by two fixing means, each of the two fixing means being substantially proximal to one of the two fixing positions,
 - wherein the carrier conveys at least one physical quantity of the object between the two fixing positions to a portion of the optical fibre between the two fixing means, and the at least one sensing element has an optical property that is reactive to the at least one physical quantity conveyed to the portion of the optical fibre between the two fixing means, and
 - wherein when the carrier is coupled to the object, the at least one physical quantity of the object between the two fixing positions is measurable by monitoring changes in the optical property of the at least one sensing element, the changes in the optical property of the at least one sensing element being substantially representative of the at least one physical quantity of the object between the two fixing positions.