Application of micro wire on the sample made from asphalt mixture with using bitumen

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Application of micro wire on the sample made from asphalt mixture with using bitumen

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Abstract. The micro wire are new possible sensors, when serves for the contactless measurement of the deformations, which arise in the sample. We can have correct measurement, with right length, diameter and application of the micro wire on the sample. The micro wire was used to two samples, which were made of asphalt mixture AC 11. Bitumen was used in order to glue the micro wire to the test sample. The signal was sufficiently strong for both test specimens. Measurement was made on a sample in the form of a beam. The reaction of the micro wire to the load applied was evaluated. Measurement was done in cycles. In total, three measurement cycles were performed. Measurement results were evaluated.

1. Introduction

At present, development and improved of materials is on high level. Therefore it is important to develop newer and smaller measurement sensors. The sensors should be able to record the changes which have been caused with various types of mechanical stress. On the bases of these sensors we are able to determine material properties. Amorphous magnetic micro wire covered with glass belongs to category of new sensors. These are sensors which consist of metallic core. Iron core is protected with glass packaging. The change of magnetic field is excited by sensor which is placed without any contact above the micro wire. The time at which the micro wire is pre-magnetized is measured. In the article it is marked as H signal and physical unit is microsecond [μs]. If is micro wire tensile, it is lengthened and time pre-magnetized is longer. The micro wire can be used to measure temperature and mechanical stress simultaneously. Moreover, it can be used to monitor material expansion. In contrast with other sensors they can scan contact parameters because micro wire diameter enables to measure the inside of the structure of materials. In order to measure correctly, it is important to select the right micro wire. They differ in diameter core, material core, diameter of glass packaging and expansion of micro wire. The aim of research is to find the right diameter micro wire, optimal length and application on the test samples. The application of micro wire to the measurement test sample must be substantially in order not to get wrong measurements. The choice of incorrect way of micro wire application will influence the whole measurement. Appropriate number of measurement is required to find optimal application, length and diameter of micro wire. The purpose of the article is to describe the way how apply micro wire on the sample using bitumen. Afterwards, the force of micro wire signal and reaction of micro wire to the loading were measured.

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2. Application of micro wire

The micro wire was applied directly to the sample while using bituminous. The length of the micro wire was 4 cm. The micro wire was inserted into the prepared groove on the sample. In order that, micro wire is straight and measurement accuracy is achieved. Subsequently, the bituminous type 50/70 is heated to 120 ° C. The micro wire is covered with bitumen. This guarantees good interaction between the test sample and the micro wire. In this way, micro wires were applied to two test samples.

The first test sample has the shape of a beam of 400 x 50 x 15 mm (Figure 1.). It is a mixture of AC 11 and 50/70 bitumen.

Figure 1. Direct micro wire application using bitumen on the beam (1st test sample).

After application of the micro wire on test sample, the H signal was detected without any deformation on the sample. The micro wire response was correct and the beam was loaded with a bending force. The Marshal test sample has a cylindrical shape (Figure 2.) with diameter d = 100 mm and high h = 75 mm. The Marshal test sample was made of asphalt mixture type AC 11 with binder type bitumen 50/70.When the micro wire had capped bitumen, H signal was detected on the test sample without any deformation. The micro wire response was correct.

Figure 2. Direct micro wire application using bitumen on the 2nd test sample.

3. Measure with micro wire

Measurements were made on a beam test sample (Figure 1).The test sample thickness was set at 15 mm (to achieve deformation even at small force and therefore the micro wire can respond to the change). The resistance of the asphalt mixture was not assessed. The signal strength of the micro wire, its response to the deformation induced, and the method of applying the micro wire to the test sample were evaluated. The test sample was tested for a three-point bend so that bending was induced (Figure 3). The micro wire was applied to the upper surface of the specimen where there is the tensile force. Moreover, an indicator watch was used to measure the deformation.

Figure 3. three-point bend with 1st test sample.

Beam was tested in three load cycles where each cycle started with an initial force of 0 N. Subsequently, the test sample was loaded to 10 N and deformation was recorded. Afterwards, the sample was gradually loaded to 20, 30 and 40 N. For each load, the deformation of the test sample was also recorded. After 40 N, the force was reduced in steps of 30 N, 20 N and 10 N until the test sample returned to 0 N. Altogether, the test was repeated three times and the resulting values are shown in Table 1.

Table 1. The course of the measurement beam in the three-point bend device.

Load	Measurement					
	1st Cycles		2nd Cycles		3rd Cycles	
Force [N]	H signal [μs]	Deformation [mm]	H signal [μs]	Deformation [mm]	H signal [μs]	Deformation [mm]
0	785.69	0.000	783.49	0.000	782.90	0.000
10	783.78	0.159	779.73	0.202	779.00	0.195
20	778.66	0.495	775.50	0.513	774.90	0.505
30	773.74	0.924	768.22	1.012	768.00	1.005
40	761.22	1.481	757.68	1.512	757.00	1.530
30	767.70	0.924	762.61	1.012	761.90	1.005
20	776.61	0.450	771.38	0.513	770.50	0.505
10	780.68	0.165	777.93	0.202	777.00	0.195
0	784.49	0.000	780.78	0.000	780.05	0.000

Measured values were plotted. The graph in Figure 4 shows the dependence between H signal and force. In the first measurement, the higher values of the H signal were measured. In the second and third measurements the sample was stabilized and almost identical values were measured (the curves in the graph are overlap).The second graph shows the dependence between H signal and deformation (Figure 5.). There was also stabilization of the test sample as we can see on the 2nd and 3rd load cycles (curves overlap).

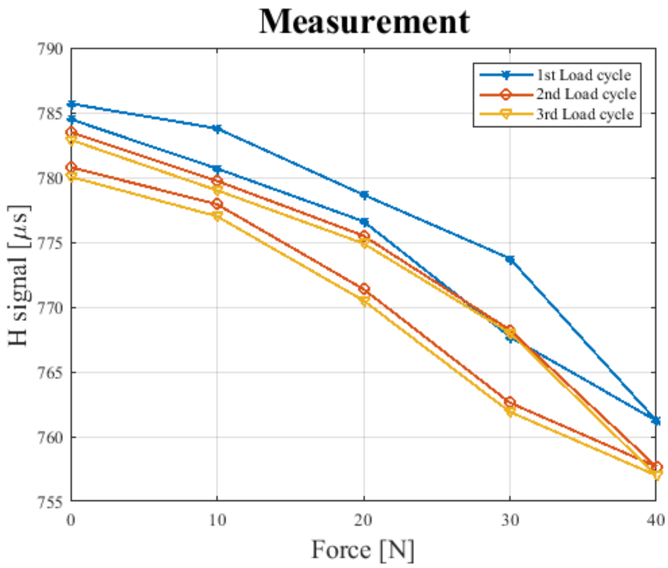

Figure 4. Direct micro wire application using bitumen on the 1st test sample, Force + H signal.

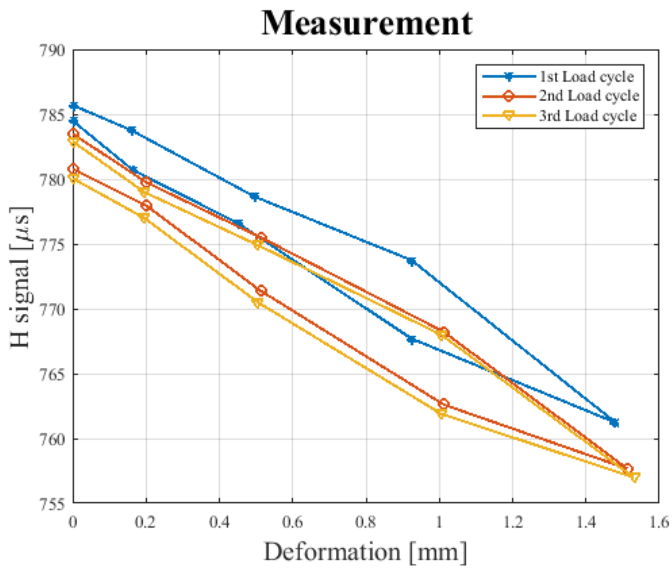

Figure 5. Direct micro wire application using bitumen on the 1st test sample, Deformation + H signal.

4. Conclusion

The application of micro wire using bitumen shows its self as the appropriate way of attachment to the test sample. Due to the fact that the same material is used in asphalt mixture the effect of non-interaction between micro wire and test sample is minimalised. Attachment of micro wire on test sample is complicated because it is necessary to heat bitumen to 110 °C. This is disadvantage. During the test correct reaction of micro wire in unloaded state was detected. The result was positive because of this reason the loading test was performed. The graph show positive results of measurement. The first test of loading cycle shows the fact, that there was consolidation of the test sample and micro wire. The second and third loading cycles represent repeatability and it is expected that the following cycles will be repeated accordingly.

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