**Report**

**Strain study at Instron (17.11.2023/23.11.2023)**

Зображення, що містить коло, земля, срібло, мистецтво

Автоматично згенерований опис

4

3

2

1

Fig. 1. Strain gauges location

**Instron conditions**

1. Torque was applied clockwise
2. Torque range 4, 20, 40 Nm
3. Port 0 - Sensor 4

Port 1 - Sensor 3

Port 2 – Sensor 2

Port 3 – Sensor 1

1. Data file (column 1 - Sensor 4; column 2 - Sensor 3; column 3 - Sensor 2; column 4 - Sensor 1)
2. LabView 2009

**Chapter 1**

**The disk is mounted on three support points (Fig. 2)**

Зображення, що містить машина, у приміщенні, Побутова техніка, циліндр

Автоматично згенерований опис

Fig. 2. Experimental setup

4 Nm

20 Nm

40 Nm

Fig. 3. Experimental results for Sensor 1

20 Nm

40 Nm

4 Nm

Fig. 4. Experimental results for Sensor 2

20 Nm

40 Nm

4 Nm

Fig. 5. Experimental results for Sensor 3

40 Nm

20 Nm

4 Nm

Fig. 6. Experimental results for Sensor 4

**Conclusions**

1. The data does not detect the stages: initial position, loading, unloading.
2. The moving average found over 30 points changes from Sentor to Sensor as follows

- The modulus value of Strain increases from sensor 3 to sensor 1 for all torque values. **So the sensor 1 is the most sensitive.**

- Within one sensor, the strain value will increase from 1.7 to 2 times when the torque changes from 4 Nm to 20 Nm; and the strain value will decrease when the torque changes from 20 Nm to 40 Nm. For sensor 1 the average value has not changed (Table 1).

Table 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Torque | Sensor | | | |
| 1 | 2 | 3 | 4 |
| Strain (average) | | | |
| 4 Nm | -6.48x10-6 | -4.15x10-6 | -2.80x10-6 | -5.94x10-6 |
| 20 Nm | -1.08x10-6 | -7.55x10-6 | -5.04x10-6 | -5.28x10-6 |
| 40 Nm | -1.08x10-6 | -5.96x10-6 | -3.49x10-6 | -4.20x10-6 |

3. The order of location of sensors (Fig. 1) for this set-up according to the obtained strain values in ascending order is as follows:

4 Nm 20 Nm 40 Nm

Sensor 3 Sensor 3 Sensor 3

Sensor 2 Sensor 4 Sensor 4

Sensor 4 Sensor 2 Sensor 2

Sensor 1 Sensor 1 Sensor 1

1. Sensors 2, 3 and 4 are located on the circle where the disc is secured, so these sensors show less Strain compared to sensor 1.

**Chapter 2**

**The disc is fixed in a four-jaw chuck (Fig. 7)**

**Instron conditions**

1. Torque was applied clockwise
2. Torque range 5 Nm, 10 Nm, 20 Nm, 30 Nm
3. Port 0 - Sensor 4

Port 1 - Sensor 3

Port 2 – Sensor 2

Port 3 – Sensor 1

1. Data file (column 1 - Sensor 4; column 2 - Sensor 3; column 3 - Sensor 2; column 4 - Sensor 1)
2. LabView 2009

Зображення, що містить земля, сталь, у приміщенні, підлога

Автоматично згенерований опис

Fig. 7

20 Nm

20 Nm

10 Nm

5 Nm

Fig. 8. Experimental results for Sensor 1 (5 Nm – blue; 10 Nm – orange; 20 Nm – gray; 30 Nm – yellow)

Fig. 9. Experimental results for Sensor 2 (5 Nm – blue; 10 Nm – orange; 20 Nm – gray; 30 Nm – yellow)

30 Nm

20 Nm

10 Nm

Fig. 9. Experimental results for Sensor 3 (5 Nm – blue; 10 Nm – orange; 20 Nm – gray; 30 Nm – yellow)

Fig. 10. Experimental results for Sensor 4 (5 Nm – blue; 10 Nm – orange; 20 Nm – gray; 30 Nm – yellow)

**Conclusions**

1. The data does not detect the stages: initial position, loading, unloading.
2. The moving average found over 30 points changes from Sentor to Sensor as follows

- For **Sensor 4** and **Sensor 3**, the differences in the data obtained at different applied torques are difficult to distinguish (Table 2). For example, for Sensor 4 the Strain is about (-1.46x10-5), for Sensor 3 is about (-7x10-6).

- For **Sensor 2** and **Sensor 1**, differences are observed (Table 2) and Strain increases with increasing applied torque.

Moreover**, sensor 1** is the most sensitive to torque changes. For example, a change in torque by a factor of 2 from 5 Nm to 10 Nm causes a change in deformation by 9.7%; from 10 Nm to 20 Nm – by 8.87%; from 5 Nm to 30 Nm – up to 27%.

For sensor 2, similar strain changes are 2.1%; 4.5% and 11.7%.

Table 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Torque | Sensor | | | |
| 1 | 2 | 3 | 4 |
| Strain (average) | | | |
| 5 Nm | -1,13х10-5 | -2,38х10-5 | -0,684х10-5 | -1,47х10-5 |
| 10 Nm | -1,24х10-5 | -2,43х10-5 | -0,689х10-5 | -1,45х10-5 |
| 20 Nm | -1,35х10-5 | -2,54х10-5 | -0,760х10-5 | -1,45х10-5 |
| 30 Nm | -1,43х10-5 | -2,66х10-5 | -0,788х10-5 | -1,44х10-5 |

1. The order of location of sensors (Fig. 1) for this set-up according to the obtained strain values in ascending order is as follows:

Sensor 3

Sensor 1

Sensor 4

Sensor 2

**Sensors 4 and 2** have the **highest strain values**. In this case, **sensor 4** is located **near the central hole,** and sensor 2 is located on the average diameter of the disk [(188-31.75)/2]. Apparently, in order to obtain greater sensitivity of these sensors to changes in torque, it is necessary to change their location, i.e. arrange them, for example, as **sensor 1**.

1. The set-up in the chuck leads to greater Strain values of the disk than setup using three support points.