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THE PROPOSAL OF TWO METHODS FOR MEASURE WEIGHT OF BEAD WIRES

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ПРОПОЗИЦІЯ ДВОХ МЕТОДІВ ВИМІРЮВАННЯ МАСИ БОРТОВОГО ДРОТУ

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ПРЕДЛОЖЕНИЕ ДВУХ МЕТОДОВ ИЗМЕРЕНИЯ МАССЫ БОРТОВОЙ ПРОВОЛКИ

This article describes the design options of sensing weight based on the principle of strain gauges. Measuring method is based on the measurement of deformations on the surface of the body, which is converted to the change in electrical resistance. This is an electrical resistance sensor, which consists of smaller cross-section wire of a suitable material and substrate for wire attached. Depending on what principle the sensor works, there are various types: such as bending, membrane, staple, ring and other. Moreover, the sensor can be made of different materials, most often of steel or aluminum alloy. The article describes two options of measuring the bead wires: dynamic measurement about the effector and measurement on the measuring stand.

Key words: *bead wire, weight measuring, strain gauge.*

Fig.: 3. Bibl.: 12.

Розглянуто варіанти дизайну ваги зондування, засновані на принципі тензодатчиків. Метод вимірювання заснований на вимірюванні деформацій на поверхні тіла, який перетворюється у зміну електричного опору. Це електричний опір датчика, який складається з меншого поперечного перерізу дроту відповідного матеріалу і підкладки для прикріпленою дроту. Залежно від принципу роботи датчика, існують їх різні типи: звивистий, мембранне, штапельне, кільцеве і інші. Крім того, датчик може бути виготовлений з різних матеріалів, найчастіше зі сталі або алюмінієвого сплаву. У статті описані два варіанти вимірювання бортових дротів: динамічний вимір ефектора і вимірювання на вимірювальної стійці.

Ключові слова: *бортовий дріт, ваговимірювальне, тензодатчик.*

Рис.: 3. Бібл.: 12.

Описаны варианты дизайна веса зондирования, основанные на принципе тензодатчиков. Метод измерения основан на измерении деформаций на поверхности тела, который преобразуется в изменение электрического сопротивления. Это электрическое сопротивление датчика, которое состоит из меньшего поперечного сечения проволоки подходящего материала и подложки для прикрепленной проволоки. В зависимости от принцип работы датчика, существуют их различные типы: изгибающийся, мембранное, штапельное, кольцевое и другие. Кроме того, датчик может быть изготовлен из различных материалов, чаще всего из стали или алюминиевого сплава. В статье описаны два варианта измерения бортовых проволок: динамическое измерение эффектора и измерения на измерительной стойке.

Ключевые слова: *бортовая проволока, весоизмерительное, тензодатчик.*

Рис.: 3. Библ.: 12.

Introduction. Bead wire is an essential reinforced material for tires on automobiles, earth-moving equipment, large trucks and aircraft. This product prevents tires from changing shape due to air pressure or external forces, and it safely locks the tire onto the rim to prevent vibration while driving. The bead wire and its placement is shown on Figure 1.

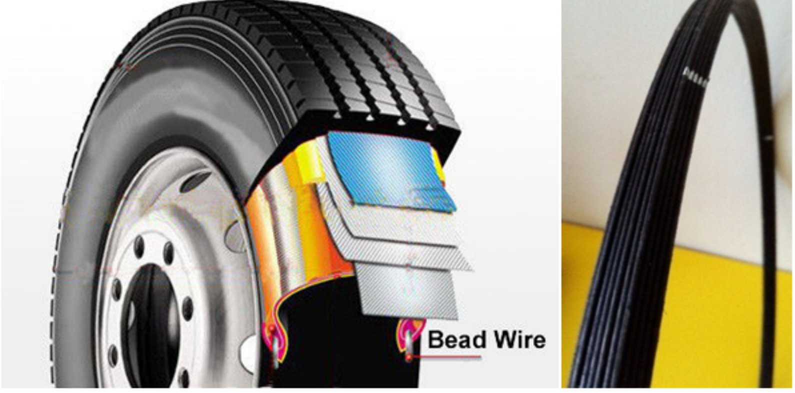

Fig. 1. The bead wire and its placement

Measurement on the measuring stand. Weight of bead wire will measure on the measuring stand, where is carried out measurement of the diameter, roundness and integrity of the bead wires. Manipulator saves the bead wire in the measuring preparation that is placed at 4 strain gauge sensors. The principle is shown on Figure 2 [1, 2, 7, 8].

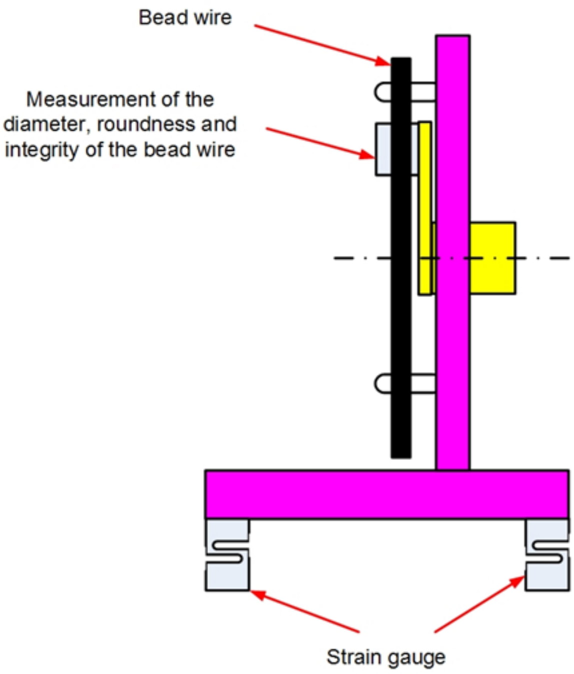

Fig. 2. Measurement on the measuring stand

Proposal of sensor for measurement on the measuring stand:

Input parameters for the design of a suitable sensor:

- Weight of measuring the stand: me = 30kg
- Weight of bead wire: mo = 0,5 to 3,5kg
- Required accuracy: ±2%
- Environment: Normal
- The number of sensors (parallel): 4 pcs

The total mass of the system is mc:

$$m_c = m_e + m_o \tag{1}$$

$$m_c = 30 + 3{,}5 = 33{,}5kg \tag{2}$$

Calculation of the required weight capacity of sensor:

$$m_n = k \; x \; m_c \tag{3}$$

The safety factor is k = 2, same as in the previous case.

$$m_n = 2 \; x \frac{33{,}5}{4} = 16.75 \; kg \tag{4}$$

The available nearest higher sensor board is board of maximum load capacity mn = 20 kg and that responds to resolution nl 3000 d by O.I.M.L.R60 [9, 3].

The required accuracy of the measuring system is data which is dependent on many factors. The basic parameter - resolution is the smallest verifiable segment. Evaluation units have a number of segments multiple large of the sensor, which thus becomes limiting segment of the measurement system. According to OIML R60 value vmin = 1/10000 rated capacity of the sensor.

$$v_{min} = \frac{m_n}{6000} = \frac{20}{6000} = 0.0033 \; kg \tag{5}$$

The accuracy of the weighing system is the highest value, which is determined by the following calculation:

Sensor limit of minimum segment

$$e_{min} = v_{\min x\sqrt{N}} = 0.0033x\sqrt{4} = 0.0066\ kg \quad (6)$$

v_{min} – minimum segment of sensor
N – number of sensors in system
Limit of weighted scale that will be used:

$$e_{min} = \frac{m_o}{n_l} = \frac{3.5}{3000} = 0.0012\ kg \quad (7)$$

The accuracy of the proposed weighting system will be the highest value = 0.007 kg. The required accuracy of the weighing system is ± 2%. That mean: in the weighted mass = 0.5 kg, it is ± 0.01 kg. It follows that the proposed measuring system complies with measuring accuracy [3, 9].

Dynamic measurement about the effector. Weight of bead wires will dynamic measuring about the robot effector. Strain gauge is installed between the end flange of robot and gripping effector, Figure 3 [4, 5, 7, 8].

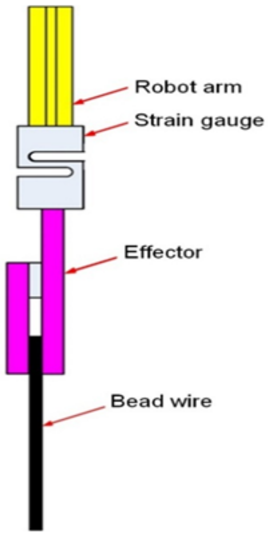

Fig. 3. Weight measurement about the effector

Input parameters for designing a suitable sensor are:

- Weight of effector: me = 8kg
- Weight of bead wire: mo = 0,5 to 3,5kg
- Required accuracy: ±2%
- Environment: Normal
- The number of sensors (parallel): 1pc

Proposal of sensor for dynamic measurement about the effector:
The total mass is mc:

$$m_c = m_e + m_o \quad (8)$$

$$m_c = 8 + 3{,}5 = 11{,}5kg \quad (9)$$

Calculation of the required weight capacity of sensor mn:

$$m_n = k\ x\ m_c \quad (10)$$

Where k is the safety factor and its value is chosen between 1,25 to 2,2, depending on the conditions of the measurement:

- The static / dynamic mode
- The presence of vibration
- Asymmetrical load
- Environmental conditions
- Factors influencing weighing system

As far as dead load greater than 50% of the gross weight is recommended use larger safety factor k = 2, with this factor considered in the required capacity of the sensor.

$$m_n = 2\ x\ 11{,}5 = 23\ kg \quad (11)$$

The available nearest higher sensor board is board of maximum load capacity mn = 30 kg and that responds to resolution nl 3000 d by O.I.M.L.R60 [9].

The required accuracy of the measuring system is data which is dependent on many factors. The basic parameter - resolution is the smallest verifiable segment. Evaluation units have a number of segments multiple large of the sensor, which thus becomes limiting segment of the measurement system. According to OIML R60 value vmin = 1/10000 rated capacity of the sensor.

$$v_{min} = \frac{m_n}{6000} = \frac{30}{6000} = 0.005\ kg \quad (12)$$

The accuracy of the weighing system is the highest value, which is determined by the following calculation:

Sensor limit of minimum segment

$$e_{min} = v_{\min x\sqrt{N}} = 0.005x\sqrt{1} = 0.005\ kg \tag{13}$$

Limit of weighted scale that will be used:

$$e_{min} = \frac{m_o}{n_l} = \frac{3.5}{3000} = 0.0012\ kg \tag{14}$$

The accuracy of the proposed weighting system will be the highest value = 0.005 kg. The required accuracy of the weighing system is ± 2%. That mean: in the weighted mass = 0.5 kg, it is ± 0.01 kg. It follows that the proposed measuring system complies with measuring accuracy [9].

Conclusion. Both measurement principles have their advantages and disadvantages. In the first case, the main advantages are price, measuring over the handling and implementation into existing equipment, but also disadvantage: lower measurement accuracy and possible damage in a crash effector (manipulator). In the second case, the measurement is a main advantage: the choice number of measurement points, measurement accuracy and measurement during the evaluation of other measurements, but the disadvantage is: measuring time-consuming and more complicated mechanics for precision.

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