

CONDUCTIVE COATED FORCE SENSOR IN CARGO TRANSPORTATION SECURITY SYSTEM

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Introduction:

This paper aims to develop a sensor for cargo security during transportation. When cargos transport on land, air and sea, goods are fastened by straps and lashes in order to prevent the lost and damage. Nevertheless, thousands of containers get lost every year due to the loose of straps. Hence, an efficient system that can prevent and eliminate this problem is on demand.

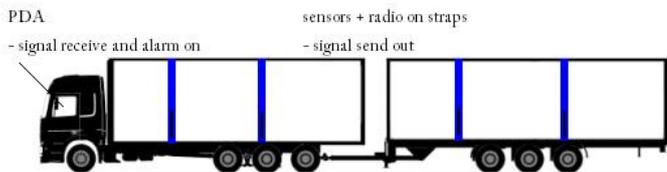


Figure 1: Force sensor used in cargo transportation system

In this paper, a sensor was developed for sensing the loosening of the straps indicated by the force change corresponds to the electrical signal change. A threshold level of force is setup according to the standard, the signal should be able to detected by a receiving device such as a PDA and actuate an alarm when force is lower than the predefined threshold force.

Testing Method:

The coated straps were tested by the standard cargo strap testing device in order to study the sensor performance. Referring to the cargo security standard, a force of 1000N to 2500 N was applied to the strap according to different amount of goods fastnesses. A force reduced to 100N indicated the loose of strap. the sensor should be able to sense the change in force when it drops into 100N as the threshold limitation, an indicate alarm should be activated accordingly.

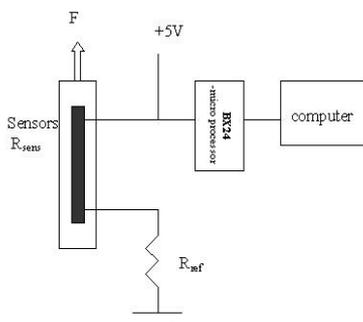


Figure 3: Equivalent circuit of testing setup

Figure 3 gives an equivalent circuit of testing setup. 5 volts voltage applied across the conductive coated part, a reference resistance series with sensor protect the overflow of currents. The force change therefore indicated as the function of voltage change.

Material and Method:

Sensor (see figure 2) were made by directly applies conductive paste on cargo security straps by coating method. Conductive paste is silicone mixed with carbon black from Wacker.Ltd.

Coating has been done by knife-over-roll method in laboratory scale. Direct coating gave high accuracy of sensitivity because of no additional substrates required. Direct coating also simplified the manufacture process.



Figure 2. Conductive coated sensor on cargo security straps

Results:

4 straps with different lengths and shapes in coating areas were tested. Voltage output of conductive coating decreased when strap stretched and elongated by applying force, the voltage change are linear to elongation showing in figure 4. A threshold had been set in order to active the alarm. By calculation the sensor has a sensitivity of 120.

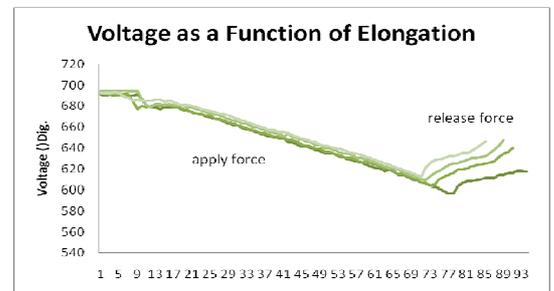


Figure 4. Result on sensor performance by apply 1000 N force and release

Ref: 1.J.Fraden.chap.2, Handbook of modern sensors.3rd Edition.
2.L.Guo,L.Berglin. Test and evaluation of textile based stretch sensors. Autex 2009