Research regarding the improvement of the methodology and means used for the balancing by weighting of bucket wheel excavators

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Abstract: -The problem, on which emphasis is laid, is how to maintain the stability and equilibrium of bucket wheel excavators or any other extraction machinery during operation, the main machinery of a technological extracting system employed for coal mining. The balance survey, respectively that of the stability of these machineries is compulsory because the bearing surface is rather small compared to the other building sub-systems outside the range of the surface, onto which much higher forces operate. The lack of correct balance for bucket wheel excavators determines their operation in an inadequate dynamic mode, or in extreme cases, there is the danger of losing stability by tilting over the excavator respectively suffering huge material and human loss. It is compulsory to verify for the correctness of the position and mass value of balance because there might be substantial error sources leading to compromise the operation. One of the most popular methods is that of weighting the entire equipment from the superior platform of the excavator.

Key-Words: - Barycentre, Tensiometric bridge, Excavator, Force Transducer, Pressure Transducer

1 Generalities

The design of a strain gauge installation, considers, on one hand, the continuous control of the position of the barycentre inside the stability field, and on the other hand, to achieve measurements for tension with the metallic construction of the excavator, in order to consolidate it or enhance exploitation time, or to repair areas where fissures or ruptures of a certain frequency will appear. The architecture, at a bloc chart level of the strain gauge timbres, of such installations is composed of, strain gauge timbres, signal amplifiers, tensiometric bridge, data acquisition card, numerical calculator, and other accessories.

The intercession generated by the necessity of designing an installation for automated processing of data, also considers the main functions and availabilities which this technical systems needs to offer, in order to ensure the keeping of data resulted, their fast processing, accuracy of the resulted data and eliminates subjectivism and error in processing the data.

2 The design of the strain gauge installation of the laboratory

The tensiometric installation of the laboratory needs to ensure two major functions, respectively:

- To be able to integrate, partially or completely, into the measurement and rehashing installation of the data used for excavators weighing procedures.;
- To be used in order to determine the voltage for each component of the metallic structure of the excavator.

In order to have a more precise, fast and efficient measurement of the voltage for the metallic structure of the excavator, and in order to research the field of "life expectancy", the DMP40S2 Type unit, manufactured by Hottinger Baldwin Messtechnik GmbH (figure 1) has been chosen as a measurement, display and recording of the data system (admittance bridge). This type of equipment allows the simultaneous connection of 16 transducers and the output of the real values and measurements by a serial protocol to a numerical computer.

Fig.1 DMP40S2 Digital Measurement Amplifier

The operating mode of the DMP40S2 device results from the basic diagram in Figure 2 where all 16 measurement channels may be observed.

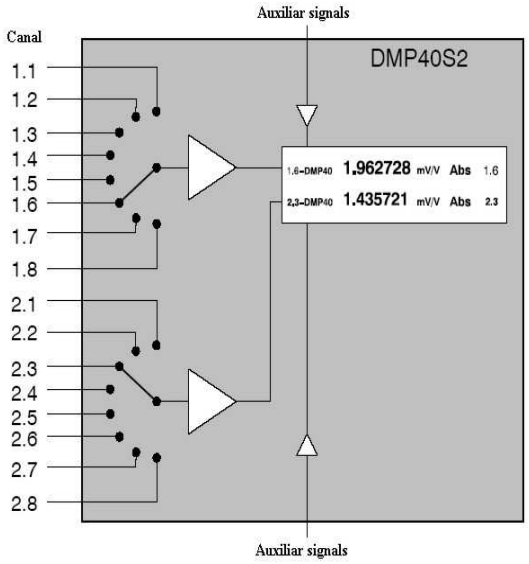

Fig.2 DMP40S2 Measurement Amplifier (operating) Basic Diagram

Figure 3 represents the Connection Diagram of the DMP40S2 Measurement Amplifier to the transducers.

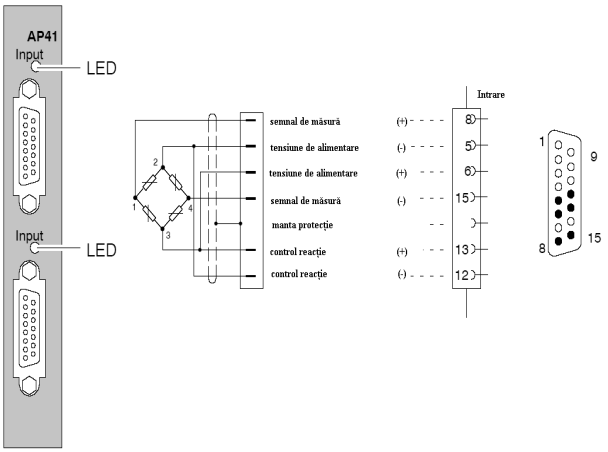

Fig.3 Connection diagram of the transducers to the DMP40S2 Measurement Amplifier

If the distance between the resistive transducers and the measurement amplifier is less than 3 m, signal amplifiers will come into use, in order to endure the safe and precise transmission of the signal given by the transducers. MC3 signal amplifiers (Figure 4) will be used for resistive transducers, while for the inductive ones MC2A signal amplifiers will be used. Both types of signal amplifiers are manufactured by Baldwin Messtechnik GmbH.

Fig.4 Signal Amplifiers for resistive and inductive transducers

Resistive strain gauges will be use for the determination of voltages and forces, e.g. the SLB-700A/06 device (Figure 5) manufactured by Hottinger Baldwin Messtechnik GmbH. Other types of srtain gauges may be used, depending on the necessities, the installation of which is made through bondage to the area following to be studied.

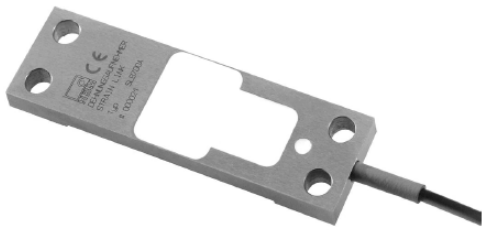

Fig.5 SLB-700A/06 Resistive Strain Gauge

3 The Conceit and Design of data measurement and hashing installation

The data measurement and hashing installation is destined to find out the size which defines the bucket wheel excavator or other machineries weighing procedure, also imposing the stability balance and control operation.

The data measurement and hashing system involves the acquisition of a measurement amplifier which is to take over the analogical

information from the transducer interpreting it and then re-sending it throughout a serial protocol to the numerical computer. Thus the data input is digital, and the role of interpreting the voltage is passing to the digital measurement amplifier (Figure 6).

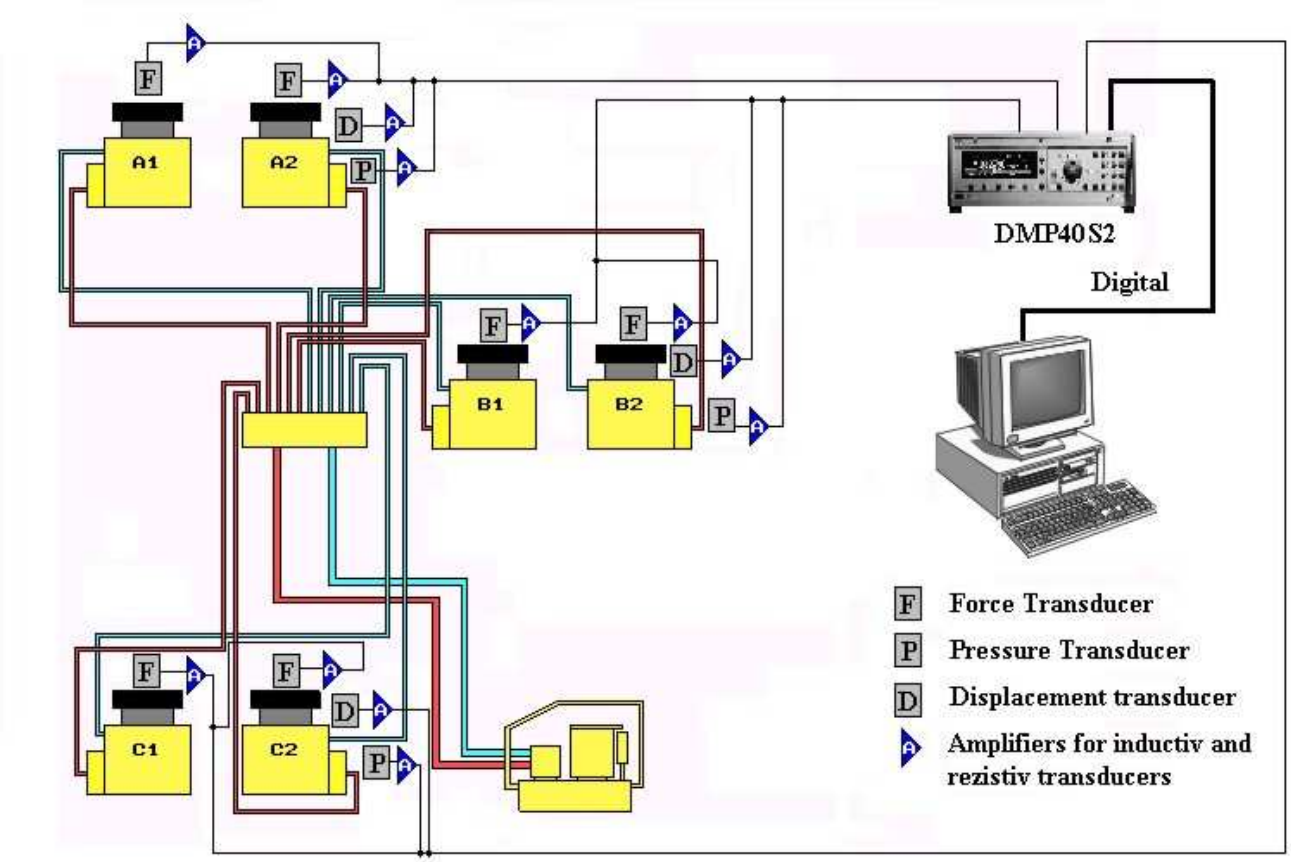

Fig.6 Data collection system from the transducers – digital signal

The C6A Force Transducer is destined to determine the lifting power developed by each hydraulic cylinder. 6 C6A Force Transducer type are used (Figure 7) manufactured by Hottinger Baldwin Messtechnik GmbH.

This measurement element represents a resistive transducer for the determination of the compression and expansion forces in a static or dynamic system. Considering the use, this element is characterised by the fact that it doesn't need maintenance and it can be installed in hard to access areas. The device's electrical output signal may be remotely transmitted in order to measure, rehash, display, and record it into a data base.

Considering the presumed value of the force, following to be measured by a force transducer, a 5 MN nominal value force transducer has been chosen.

The operating principle of such a transducer is based on the proportional variation of the ohmical resistance of the calibrated strain gauge element, deformed under the action of a force. This ohmic resistance variation induces an imbalance to the Wheatstone bridge, for when supplying it with energy, an output signal, proportional to the ohmic resistance variation and thus proportional to the compression force, will be recordced.

Fig.7 C6A Force Transducer

The three P6A pressure transducers (Figure 8) are manufactured by Hottinger Baldwin Messtechnik GmbH.

Fig. 8 P6A Pressure Transducer

The requirements of the installation, for the second case, impose the use of a P6A Pressure transducer, respectively the P6A-500B-D one with connection, with a range of 10...500 bar, and is destined to measure static or dynamic pressure in the above mentioned range.

As Displacement Transducer, a WA Inductive Transducer was chosen. This type of transducer is presented in Figure 15 and is manufactured by Baldwin Messtechnik GmbH. For operating conditions the K-WA-500W-32K-K1-LB-2-2 type was selected. The Basic Diagram and the Electrical Connection Diagram is described by Figure 9.

Fig. 9 WA Inductive Displacement Transducer

For the monitoring program of the weighing system, a software based on C language has been developed, and has the following functions.:

- It determines the calculated value of the lifting force (F_{calcul}) depending on the measured pressure and the area of the hydraulic cylinder section;
- It reads in serial the information sent by the DMP40S2 measurement amplifier;
- It compares the values of the forces for each lever, signalling any difference that passes 1%;
- It determines the coordinates of the barycentre;
- It records the measured and calculated values into a file for future rehashing.

Figure 10 represents a Print Screen of the weighing monitoring process result.

4 Conclusions

The study regarding the theoretical aspects of balancing the bucket wheel excavators, emphasises the classical mechanical theory regarding the balance of machineries and the compulsory conditions to be met in order for the machineries to be balanced when operating in practical work conditions. It is obvious that the bucket wheel excavators are still weighted according to a methodology with the help well known equipment, but the proposed solution represents a step forward, meaning the modernisation by using a computer fitted with adequate means and software on one hand, and on the other hand the introduction of the computer and of the specialized software to permanently control the position of the barycentre inside the pre-established area of balance (visible on the computer's display). If the tendencies of shifting out of the defined balance area are perceived, then, operations to bring the machinery into the position which ensures it a sure mechanical stability are necessary.

Theoretical and experimental research lead to the development of the concept called "Laboratory for weighing and strain gauge measurements", representing a modern and accessible solution in order to perfect balance and the control of stability of excavators in brown coal mines, in order to enhance mining performances, respectively their degree of use. This mobile laboratory may provide services in this field of expertise, including the determination of tension inside the metallic construction for other potential beneficiaries.

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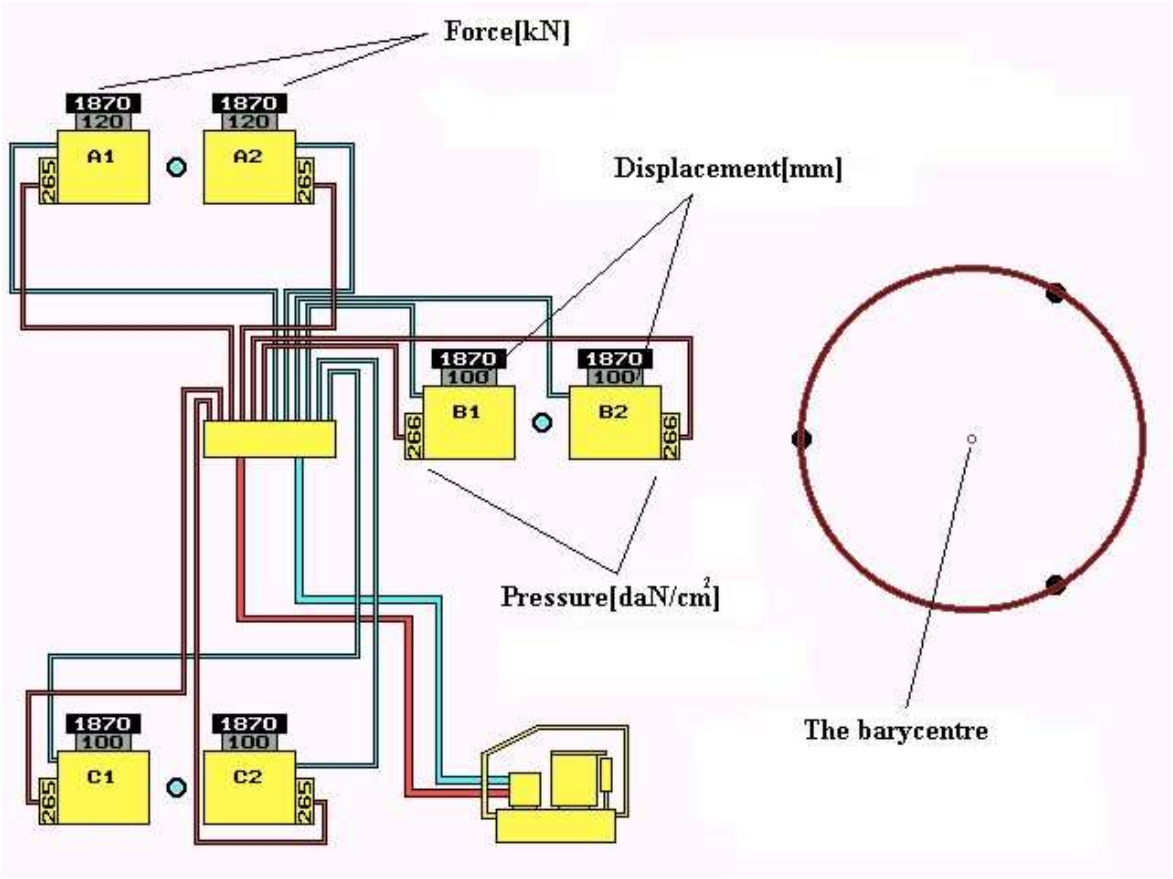

Fig.10 Monitoring Process Print Screen