ANALYSIS OF LOAD-BEARING STRUCTURES FOR QUARRY EQUIPMENT BY THE METHOD OF RESISTIVE TENSOMETRY

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Abstract: *The extraction of lignite in the coal basins of Oltenia is performed using continuous action mining systems consisting of rotor excavators, high capacity conveyors, scouring machines and equipment for depositing and removing coal in coal deposits.*

1. Introduction

The main equipment for coal discovery / extraction is the excavator with rotor type ERc 1400-30 / 7, figure 1, from the German version SRs 1400 designed by KRUPP, assimilated in Romania, being made a number of over 45 machines.

They are periodically checked during technical examinations in order to extend the service life.

Therefore, in order to assess the state of degradation of a machine and to estimate its potential operating period, it is necessary to perform comprehensive experimental and numerical tests, which are shown in the diagram illustrated in figure 2. [1].

Fig. 1 *The excavator with rotor type ERc 1400-30 / 7*

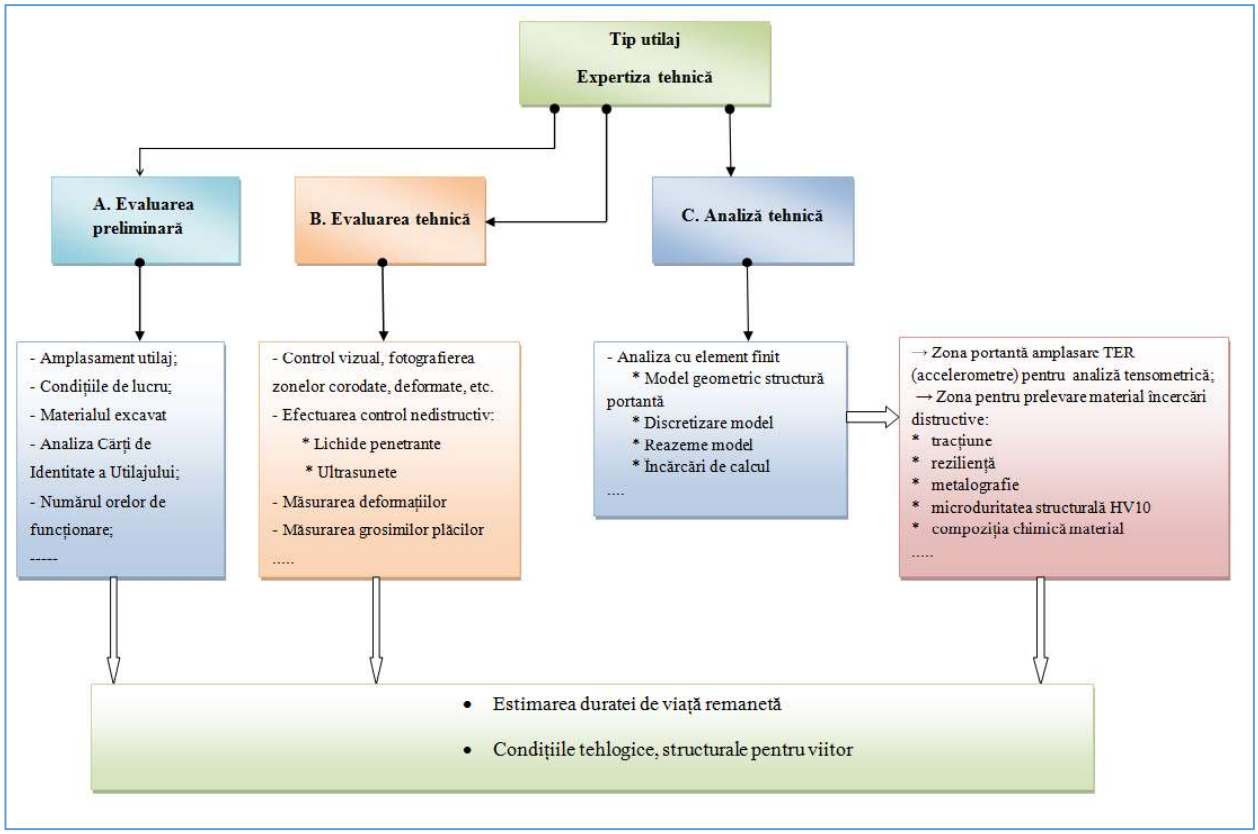

Fig. 2 *Stages for assessing the technical condition of surface mining machine superstructures*

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2. Working method used

Electrical tensometry is a method of electrically measuring non-electrical (generally mechanical) quantities.

Compared to other methods for determining the deformation of a required body, electrical tensometry has a number of advantages and disadvantages.

As advantages over other methods are mentioned:

- for measurements, the shape of the part or structure does not change;
- measurements can be performed in real operating conditions of the parts both in static and dynamic stress regime;
- has high sensitivity and precision;
- the place of measurement of the deformation can be located at a relatively large distance from the place of recording and data processing;
- the data obtained can be stored, stored or transmitted (even by radio) at great distances from the place where the measurements are performed [2].

The main disadvantage is that it does not indicate the most requested areas of the piece. The establishment of the maximum stress areas can be done using the analysis by the finite element method of the studied structures, establishing the maximum mechanical stress areas.

A data acquisition system must perform the following functions [1], [3]:

- converting the physical phenomenon into a measurable signal;
- measurement of signals generated by sensors or transducers;
- data analysis and presentation in a usable form.

The structure of a PC data acquisition system is shown in Figure 3.

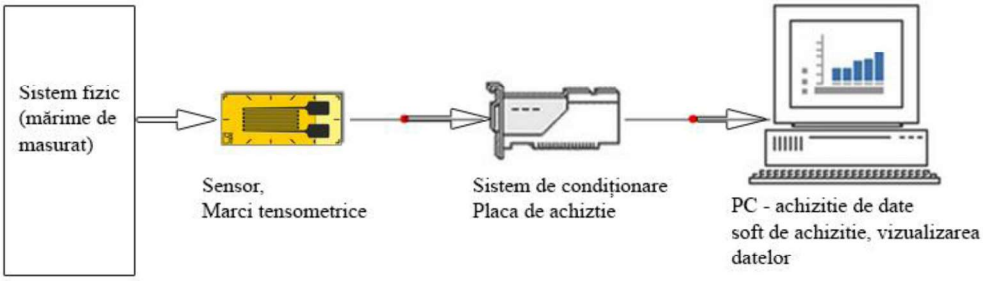


Fig. 3. *The structure of a data acquisition system*

3. Analysis by the finite element method of the load-bearing structure at the excavator type ERc 1400-30 / 7

The first stage consists in establishing the maximum stress state of the load-bearing structure, under the action of the loads given by DIN 22101, using the finite element method. The analysis used is static linear used in order to determine the strongly required areas, stresses, their specific deformations, areas where electroresistive transducers will be placed or material will be taken for destructive tests.

At the same time, this method will determine those elements that will be carefully controlled by non-destructive methods. The elements used are of the bar / plate type.

Being bar / plate type elements, the model from figure 4 was generated.

Under the action of the loads, the equivalent stress state of the load-bearing structure of the excavation equipment type Erc1400-30 / 7 was determined, figure 5.

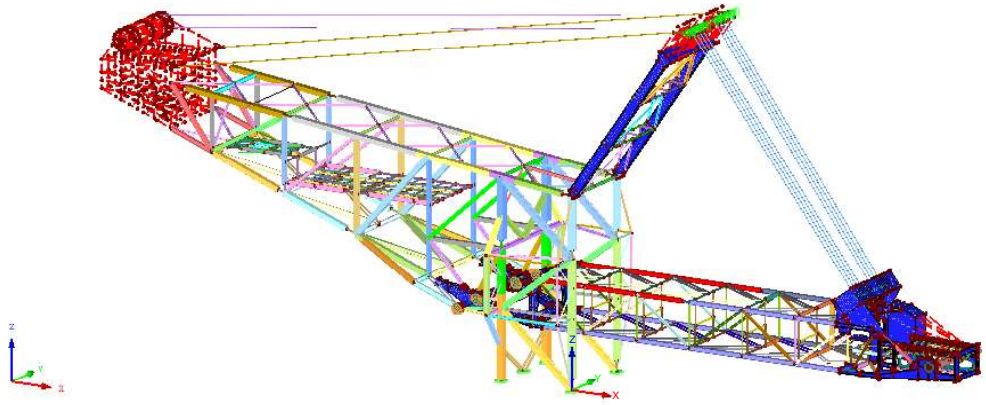


Fig. 4 *The model of calculation for Erc 1400-30 / 7*

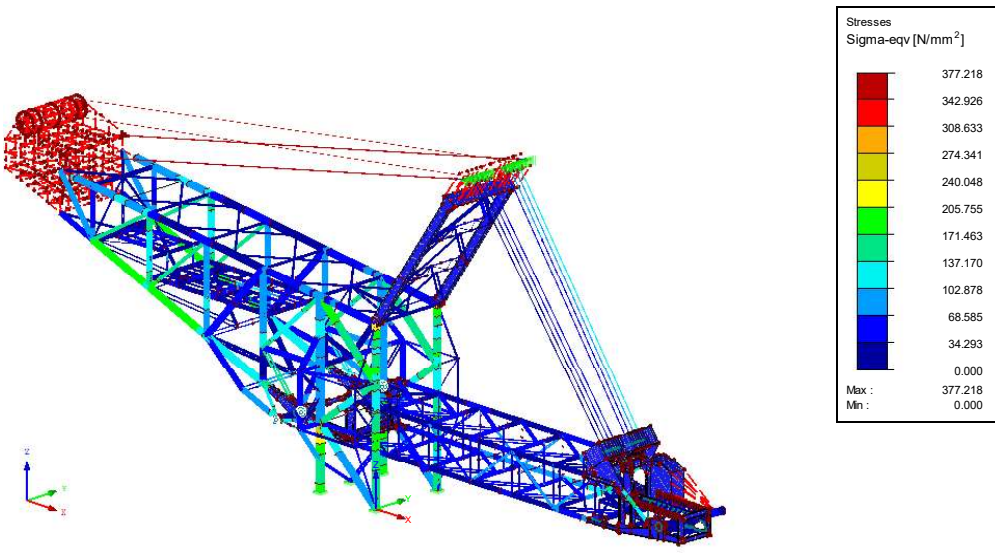


Fig. 5. *The state of tension on the load-bearing structure of the machine*

Following the analysis, it was established that the areas with major mechanical stresses are: Z.1, Z.2 - balance arm; Z.3 - Tower pillar; Z.4 - wheel arm with buckets.

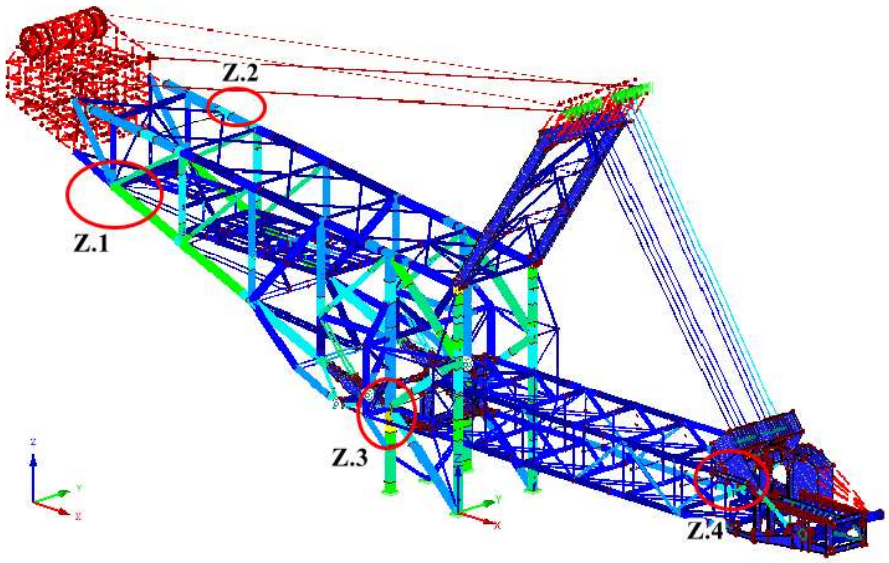


Fig. 6. *Areas with major mechanical stresses*

4. Tensometric analysis of the load-bearing structure of the machine

Depending on the working condition of the machine, tensometric analyzes can be performed:

1. *Stationary* - the machine does not have an excavation front, being stopped for a period of time on a site. Tensometric recordings will be made from the rotation of the upper platform + raising / lowering the arm of the bucket wheel;
2. *Dynamic* - the machine has a work front and can move. In this case, tensometric recordings will be made from the excavation in the working front using a normal regime of advance and displacement.

The next step is to glue the tensometric grains in the places established by the finite element method. The electroresistive transducers (TER) used are manufactured by KYOWA, Japan type KFGS-6-120-C 1-11. The transducers were applied with a CC-33A type adhesive manufactured by KYOWA. The connection scheme is in a half-bridge, one of the translators having the role of thermal compensator.

The positioning of the tensometric marks was done on the metal construction, figure 7.

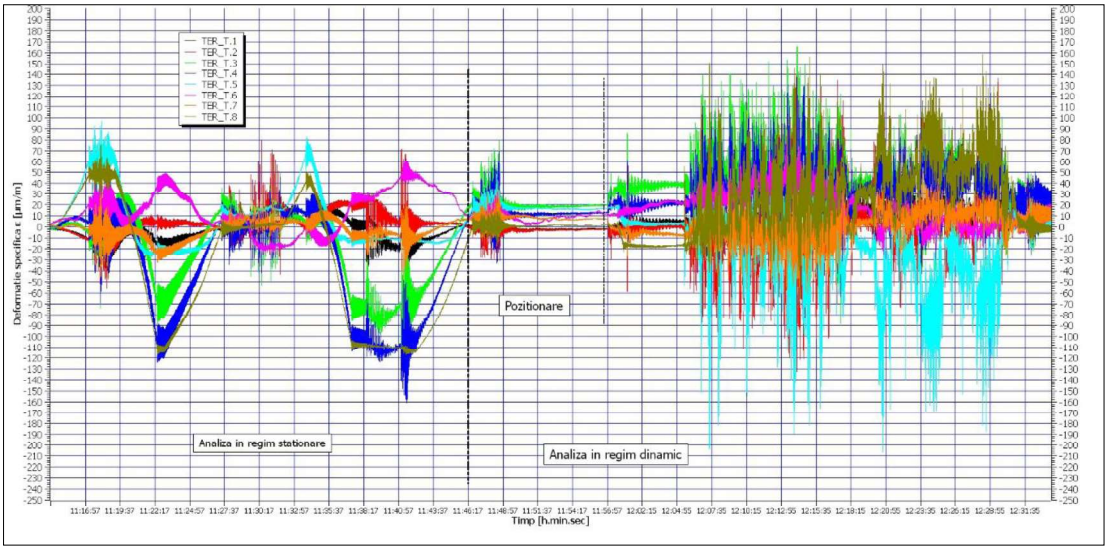
After calibrating the equipment and starting the machine, the two types of recordings were made, stationary and dynamic, figure 8.

Balance arm

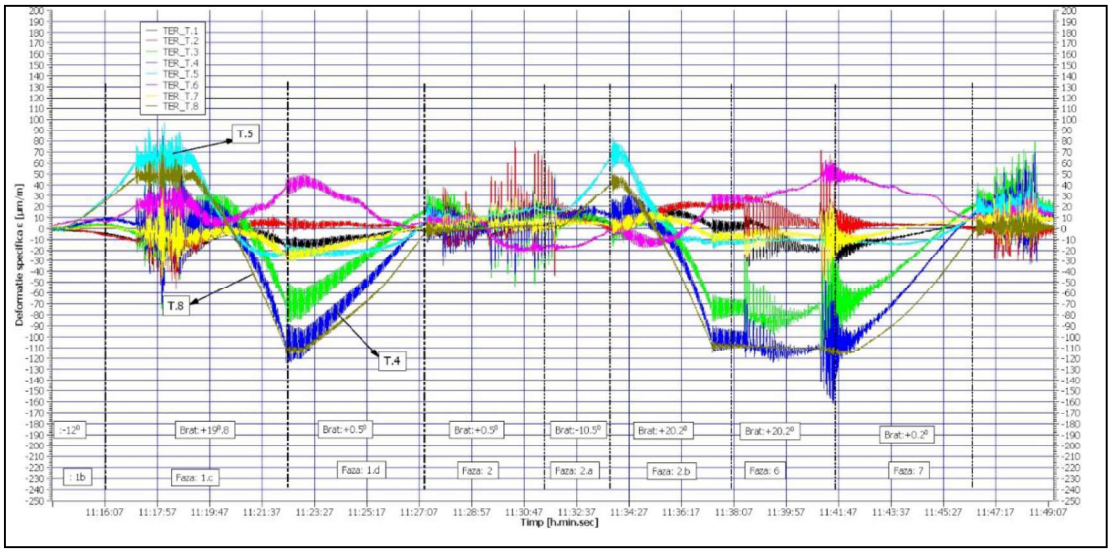
Pillar - central tower

Wheel arm with buckets

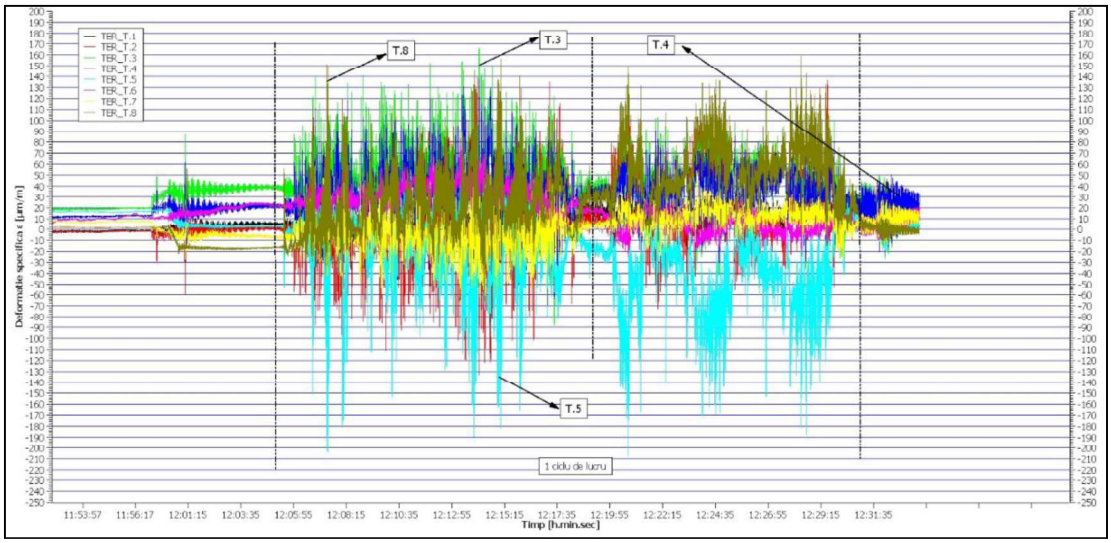
Fig. 7. *Positioning of tensometric marks on the load-bearing structure*



Stationary / dynamic tensometric recording



Stationary tensometric recording



Dynamic tensometric recording

Fig. 8. *Recordings, stationary / dynamic*

5. Conclusion

- A good correlation can be observed between the model made by the finite element method and the tensometric recordings;
- The sizes of the static recordings are much smaller than the dynamic ones, but they give information on the behavior of certain mechanisms in operation, for example the rotating bearing of the machine.
- Using the measured voltages, the fatigue curve can be drawn for the respective machine.

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