NON-DESTRUCTIVE ANALYSIS METHODS USED TO VERIFY THE LOAD-BEARING STRUCTURE OF THE EQUIPMENT USED IN THE OLTENIA MINING INDUSTRY

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ABSTRACT: *In the mining region of Oltenia, the equipment used to extract coal already has a service life of over 30 years, so special attention is required regarding any existing or probable defects of the component parts. When a defect occurs, the question arises from the point of view of its origin, in order to eliminate the cause that produced it. This characterization is the responsibility of the maintenance staff. Regular control of the machines, technical revisions can often prevent malfunctions. The detection of malfunctions can be done by visual checks or with special means. This paper presents the most frequent defects in machinery and installations as well as modalities of localisation and evaluation. Knowing the technical operation condition and prevent the occurrence of large defects or of those with significant consequences in production becomes a necessity.*

KEY WORDS: *mining equipment, defect,*

1. INTRODUCTION

The process of extracting lignite from the Oltenia coal basin is carried out using technological lines consisting of: rotor excavators, equipment for uncovering, conveyors with high capacity tape, dumping machines, for the deposition in dumps and equipment for depositing and extracting coal from the coal deposits.

All these machines have an operating duration of more than 10 years; they are produced from 1975 to 1990.

After 1990 some of these machines, especially the Erc 1400-30/7 wheeled excavators, were upgraded to the cutting system, but without making any changes to the load-bearing structure. Due to the long service life, it is necessary to periodically monitor the operation, to find the defects occurred in order to intervene in a timely manner if necessary, in order to ensure the safety in operation. Regular control of the machines, technical revisions can often prevent malfunctions.

The detection of malfunctions can be done by visual checks or with special means.

2. DEFECTS IN MINING EQUIPMENT, LOCALISATION AND EVALUATION

For material imperfections, names such as: defect, non-conformity, discontinuity and, more recently, imperfection are used. The SR EN ISO 9000-2006 standard recommends the use of the notion of non-conformity, the new standard for defects in parts recommends the use of the notion of imperfection.

The concept of non-conformity is defined as the deviation or absence of one or more of the quality characteristics or elements of the quality system in relation to the requirements specified, the quality characteristics of the products being concerned.

Like other notions used in the technical field, the notion of defect has been standardised. The existing defects in the machines have various origins and the causes that determine them can often be diminished but not completely eliminated. When a defect occurs, the question of characterization arises from the point of view of its origin, in order to eliminate the cause that produced it. This characterization is the responsibility of the maintenance staff.

The defects can be divided according to different criteria, the most important of which is that of the origin of the defect:

• defects in conception: improper calculation; inadequate construction; improper choice of materials; improper lubrication.

• execution defects: inadequate technologies; incorrect processing; incorrect storage of parts (especially of the metal construction stored over a long period).

• mounting defects: improper manipulations; wrong placement of the pieces; modification of macro geometry.

• operating defects: wear of the sliding surfaces; mechanical overload; thermal overload; improper lubrication; damage to functional surfaces: wear of teeth, buckets, metal plates, scrapes, rubber mat, drums, etc.

The conception defects are difficult to discover and require knowledge of the theoretical bases that were the basis of the conception of the respective construction. These defects are serious if they affect large series of machines or high-capacity machinery such as rotor excavators.

A concrete event is that of the ERc 1400.30/7 excavator at which the plain bearings of the rotor boom joint have been replaced by bearings. The malfunction registered in 1973 at the excavator 1237 from the Garla quarry in the Rovinari Basin led to a shutdown in operation of about 40 days. Examples of this type of machine can continue.

The execution defects arise from neglecting of the technological discipline during manufacturing, the replacement of the original materials with others of low quality (such as the metallic construction) or from the poor training of the contractors.

The mounting defects can occur due to the manual interventions that are difficult to control during the assembly, as well as to the mounting errors (uneven tightening of the jointing parts due to the lack of adequate tools, forgotten parts on the outside, etc.). There are many examples of mounting deficiencies that led to damages.

The installation of high-capacity equipment in the quarries will continue to be done on specially arranged platforms, properly equipped with specialized equipment and tools with specialized workers. Ongoing technical assistance from the supplier must be provided.

Operating defects are the frequent causes of damage and have a decisive influence on safety in the operation of machinery. Brutal manipulations and overwork are the causes of exploitation defects. In some situations they caused catastrophes by the collapse of the machines (examples are the excavators from the Panga and Husnicioara West quarries) for the remediation of which huge sums were spent and production losses were recorded due to the long periods of long periods of interruption of operation - over one year.

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The detection of malfunctions can be done by visual checks or by with special means.

The repair and technical maintenance of the transport machinery and equipment, through the use of means of technical diagnostics, is a problem of great topicality and of particular

importance for the increase of their intensive and extensive use indices

3. REGULAR TECHNICAL CONTROL OF THE MINING EQUIPMENT

Regular control of the machines, technical revisions can often prevent malfunctions.

The use of the most appropriate equipment for performing with maximum efficiency the technical diagnostics during operation or stationary, without dismantling the machine refers to the following main issues and tools:

• For the diagnosis of lubrication: devices for ironography; instrument for measuring iron filings in used oil, with indication of humidity in oil; indicators of the content of volatile substances in oil (based on the physical method); instrument for atomic absorption spectrophotometry; meters for oil-dispersed particles (in groups by size), for the testing of hydraulic oils.

• For searching defects, through defectoscopy: defectoscopic devices based on ultrasound; Roentgen instrument; magnetic defectoscopes; detectors with liquids and paints; devices for controlling the integrity of the metal construction and the rectangularity of its elements; installations for the control of weld joints.

• For the diagnosis of vibrations: vibration measuring instrument; data collectors with memory and possibilities of transmitting and entering into the computer data for measuring vibrations; computer with data storage for storing and processing data for the frequency analysis with the possibility of determining the detection directions at the investigated machines; portable frequency analysers.

• Other devices for technical diagnostics: equipment and instruments for the control of electrical cables, establishing the place of failures in cables; installation for the control of the rubber carpet and of the joints; thermometers; infrared thermometers with high angle and angle of 0.4° at the top; installation for determining the temperature with display and accessories; micrometres with numbers with measurement of the thickness of the metal objects and of the rubber coating, measurement of paint and varnish coating; instruments for defectoscopic control of the steel cables; instruments for the control of transformers and the detection of technical condition; devices for the control of the voltage states of the metal constructions and other instrument.

Knowing the technical condition and prevent the occurrence of large malfunctions or damages with significant consequences over production and over the economic situation of each unit becomes a necessity.

Knowing the defects involves going through the following steps:

- knowledge of the types of defects that may occur depending on the nature of the material, the way of design and the technological process of fabrication;
- detection of defects, reporting their presence;
- localisation in relation to a conveniently chosen reference system, establishment of the position where the defect is located in relation to the outer surfaces of the part;
- measurement and estimation of the shape, volume and size of the defect is often approximated by the size of a geometric figure in which it can be inscribed, sphere, parallelepiped or by projecting it on a surface or by taking into account the size of the largest, called characteristic dimension;
- Estimation of the tendency to evolve over time, the propagation evaluation (two-dimensional defects such as cracks have a higher propagation tendency than three-dimensional ones);
- Comparison of the actual characteristics of the product affected by the presence of detected defects with the

values set at the equipment design or prescribed for those characteristics

- Making a decision on the acceptability of defects detected in accordance with norms.

4. DEFECTS THAT CAN OCCUR IN MINING EQUIPMENT

In mining equipment, it is very important to early discover and degree of the danger in relation to the operation process of the defects that can occur in this respect, to know the degree of their grouping, the technical feature that it is affected, the frequency of occurrence, the degree of accessibility to detection and also the evolution in time.

By their importance and degree of danger in relation to the operation of the product, defects can be critical, major or minor. A critical defect is considered the non-compliance of a product that causes a lack of safety or can lead to injury to users. A major defect is considered to be the one that, without being critical, substantially reduces the possibilities of using the product in question or may cause a failure that prevents its operation. A minor defect is a non-compliance that reduces comfort, affects aesthetic characteristics or significantly diminishes the functionality of the product.

Depending on the destination of the product, defects that occur in mining machinery are: dimensional deviations, defects in the shape and mutual position of the surfaces, deviations from the quality of surfaces, structural defects, deviations from mechanical characteristics, discontinuities, and other deviations.

Also, by the frequency of occurrence certain type of defect can occur systematically, based on a systematic error or its occurrence can be accidental, caused by accidental causes

By the degree of grouping, the defects can be: single, grouped, spread or scattered.

In heavy machinery industry it is most important to have access to detection. This is of particular practical importance as it determines both the examination technology and the equipment needed for detection.

Depending on the position in relation to the surfaces of the parts and the degree of accessibility, the following situations were observed: external defects, generally easily accessible, interior defects, generally harder to reach, and are either located on the inner surfaces or located inside the walls of parts. Defects also can be found near the surface (communicating with the outside or not), inside the piece at a certain depth, far from the accessible surface.

These defects are difficult to detect because of the danger it poses to the health of the human operator (in toxic environments, in radioactive environments, at high temperatures, and due to the distance: at high altitude, at great distances or depths.

It is also difficult to have access to this type of defects due to the location, inside an assembly: vacuum enclosures, under high pressure, sealed products.

By evolution in time or by propagation tendency under the action of external stresses or of residual internal forces there are defects without a tendency to propagation, good-behaved, which stand still and do not develop during exploitation; they are usually three-dimensional and have rounded contours (winds, voids), defects with a tendency to propagation until the breakage of the product: usually two-dimensional or three-dimensional with sharp contours (cracks, halves, defects that appear in the thermos-mechanical notching process).

Defects in the second category are the most dangerous because they have a notch effect, so the detection techniques are aimed primarily at them. The location and measurement of defects shall be carried out in relation to a conveniently chosen reference system.

5. CONCLUSIONS

The defects, mostly due to the corrosion effect over time, can seriously affect the load-bearing structure of the machines most often the defects given by the intercrystalline corrosion under voltage (corrosive cracking), which is not visible by eye.

For machines with an operating period of more than 10 years it is necessary to perform non-destructive control even during monthly repairs in the heavily used areas.

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