1 Introduction

The aim of the research was to identify the loads on multicaterpillar track chassis and calculate the strength of elements of chassis. The measurements were taken on open cast mine machine: mobile transfer conveyor, shown in Fig. 1. The biggest problem in such kind of machines is to properly diagnose the state of machine and remove from usage before any dangerous, for people and machine, accident takes place [1, 2].

The aim of the research, the mobile transfer conveyor A2RsB 12500 was designed in early 70' last century, on the basis of TGL Standards [8]. There were many indefinite problems, which are still unknown. Nowadays we cannot answer the question how long the machine will work without any failure, therefore the assessment of actual technical condition needs to be done.

2 Multicaterpillar track chassis

The chassis of open cast machines like mobile transfer conveyor consists of up to 12 caterpillar tracks connected into sets of 2 or 4, of which some are steered. The scheme of chassis that is the aim of the research is shown in Fig. 2 [3, 4].

Multicaterpillar track chassis consists of 6 caterpillar tracks which are connected by axis and the steering drawbar. The scheme of the chassis is shown in Fig. 3. Two caterpillar tracks are connected into one set, where there are 3 sets. Two of the sets are fixed and do not have the possibility to turn, one set is steered by driveshaft and has a possibility to change the relational angle between the portal of the machine and the main axis of the set. Tracks are powered by electric motor, one caterpillar track by one motor.
3 Boundary conditions

Nowadays standards state that the friction is held at the value of 0.6. It is the maximum value that is taken from the update standards [7]. Several cases of loads and boundary conditions are used for strain calculations. According to the standards, loads cases do not include all of the possibilities of real loads [3, 5]. In the presented paper the most popular cases of used boundary conditions are shown. In Fig. 3 the boundary conditions used for calculations of caterpillar track are shown [6, 7, 8]. The caterpillar track is loaded on each arm or on drive-wheel and tension-wheel. The caterpillar track is fixed on its axis bushing. The forces $F_1$ and $F_2$ are generated by the reaction with the ground, the force $Q$ is the result of the interaction with the ground during the turning, force $F_b$ comes from the reaction of electric motor.

![Figure 3 Scheme of load on caterpillar track](image)

The most appropriate for the calculations of steering drawbar case of boundary conditions is to fix one end of the steering drawbar and apply force at the other end in the horizontal direction, that is perpendicular to the main axis of the drawbar and the vertical force applied to the place, where the ball joint is situated.

4 Numerical measurements

Numerical analysis was done using the Finite Element Methods. Calculations were done for 5 different schemes of loads on caterpillar track and for 2 different schemes of load on driveshaft according to the standards. Some of the results of calculations of caterpillar track are shown in Figs. 4 to 7 and the calculations of driveshaft are shown in Figs. 8 to 10. In Figs. 11 and 12 are shown the results of nonlinear calculations. The maximum value of stress calculations is lower than in the linear calculations and the field of maximum value is smaller.

![Figure 4 Results of numerical stress calculation of caterpillar track (Pa), load set 1](image)

![Figure 5 Results of numerical stress calculation of caterpillar track (Pa), load set 1](image)

![Figure 6 Results of numerical stress calculation of caterpillar track (Pa), load set 2](image)

![Figure 7 Results of numerical stress calculation of caterpillar track (Pa), load set 2](image)
5 Strain gauges measurements

Strain gauges measurements were performed in 9 measuring points. There are 6 points on caterpillar tracks where the traction forces were measured. Strain gauges were located on the supports of caterpillar’s track, where the motion is fitted. The other 2 strain gauges were located on each truss and the last one was located on the drawbar. The measurements were taken during the drive in different directions: forward and backward, with different positions of the center of gravity, with different positions of the load carrying structure and the chassis. The measurements were taken during machine turning to the right and to the left, driving forward and backward with and without the overburden. During the measurements over 30 sets were recorded.

The data acquisition was conducted by multichannel recorder. All of the signals were recorded parallel with each strain gauge.

6 Results of strain gauges measurements

Results of the measurements show that the real traction force is not linear, but very stochastic. Traction force was gained during driving forward and backward. Traction force for forward drive is shown in Fig. 13. The average value is at the level of minus 50 kN with amplitude at the level of 70 kN.

The results of measuring the steering force are shown in Fig. 14. The most important thing in this measurement is to show how the force changes its value during turning the steering caterpillar track set. Steering force changes from 0 kN to over 600 kN during turning.
Measured steering force is over 3 times higher than the force calculated by using analytical method. The calculated steering force depends on static variables and is not related to the change of the angle of the steering set. Measurements show that the force changes its value during the steering and driving the entire machine.

7 Conclusion

There are many indefinite problems with the loads on the chassis of open cast mining machines. Existing equations do not take into consideration any stochastic loads. The measurements show that the traction force changes very rapidly and has a very high value of amplitude. Currently there is lack of guidelines to receive the appropriate boundary conditions and operational loads. It is necessary to conduct more research on open cast mining machines to define more properly the loads acting on multicatertpillar track chassis. The measurements should be taken in different conditions: during the winter and the summer, when the ground is frozen, wet and muddy or dry and sandy. Research should be done in different positions of the entire machine and with or without transporting the overburden.

8 References