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INCREASING OF WORKING LIFE OF CONVEYOR BELTS AFFECTED BY SHOCKS

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Abstract: *This paper contains the project overview of complex research of conveyor belts affected especially by impact (shock) loading. The main task is to increase working life of conveyor belt based on optimization of size and shape of transported parts, dropping height, design of the belt and impact area. Project contains theoretical, experimental and numerical analyses. The best types of modifications will be realized in the surface mining company. Project is oriented especially to optimization of drive and return stations using of detailed numerical models, new design concepts and materials. Project also proves possibilities for size and shape monitoring of transported parts and active modification of geometry based on type of transported materials.*

Key words: *Conveyor belt, Impact damage, FEA, Experimental measurement, Monitoring of transported parts*

1 INTRODUCTION

This paper contains the research and development project overview of conveyor belts affected by shocks in brown coal surface mine. The project started on 3/2012 and finish is planned on 12/2014. This project is solved in cooperation with IDIADA CZ, TU of Liberec, Severočeské doly a.s. (SD a.s. - brown coal producer), Ministry of Industry and Trade and FBERG TU of Košice. The aim of this project from R&D point view is to achieve the know-how in the field of simulation and optimization of conveyor belts. The aim from realization point of view is to design, manufacture and test the solutions for working life improvement of conveyor belts for transportation of overburden soils.

The total length of conveyor belts operated in SD a.s. is approximately 270 km. Approximately 1/3 of these belts are affected by shocks – 43km (belt width 1800mm) + 19km (belt width 2000mm) in Bílina mine a 30km in Tušimice mine. The price for 1m of belt 1800mm (type P2500/4+1-8x4 A) is approximately 300€. Planned average working life of belts in SD a.s. is 5 years. Real working life of belts affected by shocks is only 3 years. The total cost for belt replacement is approximately 27 million € / 3 years (740.000€ / month). It follows that even a small increase of working life of the belts brings significant cost savings. [5]

2 PROJECT DESCRIPTION AND PHASES

2.1 Analysis of operating conditions and problematic areas

First project phase contains the theoretical and experimental analyses of operating conditions of overburden soils conveyor belts. Analyses are oriented especially to drive and return station Noen DPD 1800 and conveyor belts Contitech P2500/4+1, 8+4 A. The main task of this phase is to obtain basic information and critical factors for next phases. Attention will focus on design of drive and return station, impact forces, vibrations, types of transported parts, types of damages (Figure 1) and other factors. Also the complete transport chain (wheel excavator – grinder – drive and return station) will be analyzed.

Figure 1 *Damages of the conveyor belts – SD a.s. Bílina surface mine*

2.2 Effect of size and shape of transported parts

The main task of this phase is to improve the working life of conveyor belts based on optimization of size and shape of transported parts. The important part is to obtain the information for complex numerical simulations of conveyors. In the first year of this project the vibrations of shield and impact area of return station (impact rollers) was measured (Figure 2 and 3). This measurement was made for different shield and slider positions by measurement device DEWE-5000 and accelerometers Kistler 3D K-Beam, Kistler 8305B2 and Analog Devices ADXL203. The additional slider was installed in the return station impact area as protection against impact. This slider could be manually moved into falling transported material. The project will check the possibility for automatic slider positioning depends on vibration intensity. Slider will be extended only for higher vibration intensity which corresponds with bigger size of transported parts. This component could not be permanently extended due to congestion of sticky material (clayey soil). Project also proves the possibilities of laser measurement sensor LMS511-20100 (Figure 4) which is actually used for monitoring of volume of mined (transported) overburden soils. This system scans the soil cross-section on the belt and could be potentially used to monitoring of part sizes and automatic extension of

slider.[5]

Figure 2 *Vibration measurement – measurement device DEWE-5000 with high speed camera (left) and accelerometer placement on the impact rollers (right)*

Figure 3 *Vibration measurement – accelerometer placement on the hydraulic cylinder of the shield (left) and detail of 3D accelerometer Kistler K-Beam*

Figure 4 *Laser measurement sensor LMS511-20100*

Operating conditions of conveyor belts in surface mine SD a.s. are very difficult. Impact damages of large and sharp blocks are dominant for this service. The grinders and slicers are used for elimination of large blocks. However after usage of these systems sometimes occurs blocks with very large dimensions e.g. 500x500x1000mm. [6]

2.3 Effect of dropping height

The main task of this phase is to improve the working life of conveyor belts based on optimization of dropping height of transported parts. This phase is oriented especially to construction modifications of existing design (Figure 5). The dropping height reduction has a positive effect on the working life, but it is also important to check the complications based on congestion of impact area caused by lower dropping height. Dropping height together with size of transported parts has main

effect to the size of impact energy. The part of this phase together with previous phase is to define the shape and speed of the impact device as inputs for numerical simulations. [2]

Figure 5 *Dropping height optimization*

2.4 Effect of design of conveyor belt

The main task of this phase is to obtain the material model of the belt Contitech P2500/4+1, 8+4 A for complex numerical simulation of conveyors. Project also examines the possibility of alternative type of belts. Material model will be created based on information from experimental measurements of uniaxial tension, biaxial tension, impact (breakthrough) test [1,2] and 3 axis bending (Figure 6 and 7). The Mooney-Rivlin hyperelastic material model for rubber layers and elastic isotropic material for polyamide layers was used as a base. Project also tests the alternative material models (e.g. Holzapfel-Gasser-Ogden).

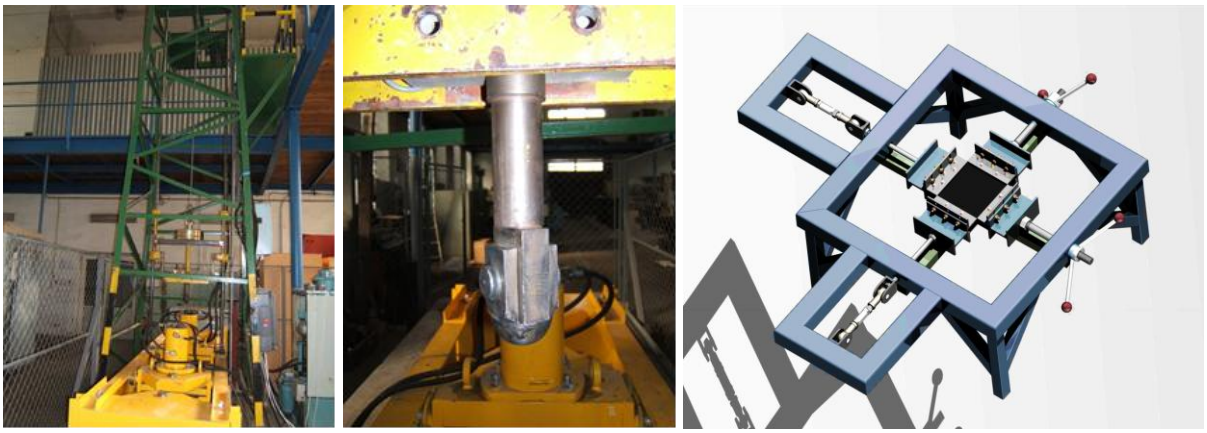

Figure 6 *Experimental measurements of the belt (FBERG TU of Košice) – breakthrough (left) and biaxial tension (right) equipment*

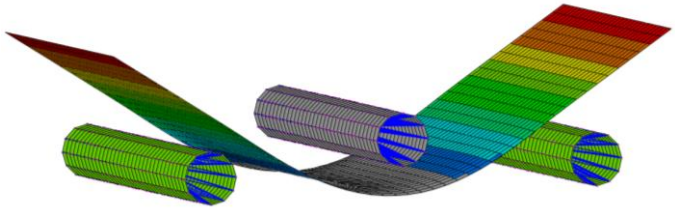

Figure 7 3 axis bending simulation of conveyor belt (Abaqus)

2.5 Effect of design of impact area

The main task of this phase is to improve the working life of conveyor belts based on optimization of impact area. The important part of this phase is methodology development for complex static and impact numerical simulations of conveyors. This model could help optimize especially the

design of impact area. Attention will focus on spacing of rollers, stiffness of roller suspension and additional damping components.

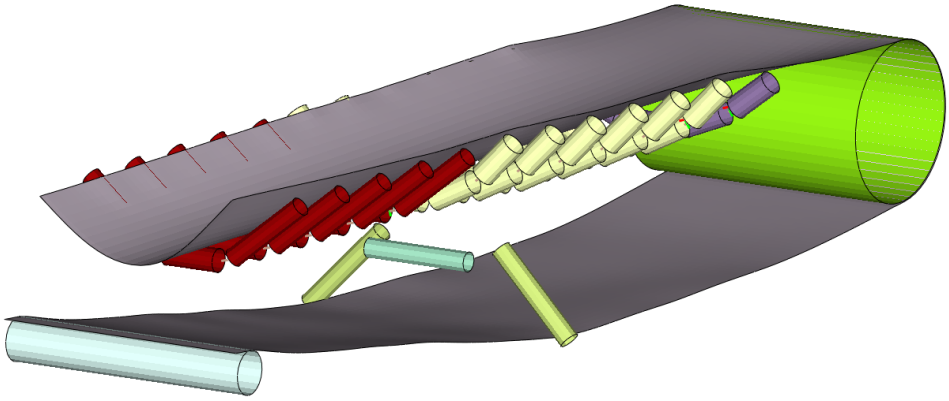

Figure 8 *FEA – Impact area simulation (Abaqus)*

2.6 Practical realization of improvements in surface mine

The knowledge's gained in the previous phases will be used for identification of changes having a positive effect to working life of conveyor belts. The changes having the highest potential for working life improvement will be realized in SD a.s. Bílina surface mine. Practical realization and its verification are planned to year 2014. We suppose the practical realization of dropping height modification, automatic slider positioning and optimization of impact area of return station. [3]

3 CONCLUSION

The aim of the project is design, practical realization and verification of new solutions for working life increasing of the belts affected by shocks. The advanced numerical methods will be used for simulations and optimizations of conveyors. These approaches reduce the costs required for experimental measurements of proposed modifications and allow analysis of larger amounts of the modifications. Achievement of project objectives brings cost savings related to reduction of material and work costs and reduces also the ecological burden.

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