WMESS 2018
World Multidisciplinary Earth Sciences Symposium
3 - 7 September 2018, Prague - Czech republic

Estimation of purchase and replacement costs of conveyor belts and their splices in an underground mine based on their durability

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Introduction

A cost model for the purchase and replacement of conveyor belts using the average durability of belts and splices of various types (including adhesive and vulcanized splices) was developed for a hypothetical underground mine which uses continuous belt transport. Variant cost models of belt maintenance were developed for the given belt purchase prices and costs of splicing belt segments in the loop. The investigations focused on how the total costs of belting are influenced by various factors, including: belt prices, splicing costs, durability of belts and their joints, type of splicing, time and costs of planned and emergency belt replacements. The analyzes were performed without taking into account random differences in durability, and therefore the confidence interval for total costs for the given confidence level was not presented. The calculations were based on data obtained from users. They were not preceded by any statistical analyzes of actual operating times for either belts or splices. The results are therefore of qualitative rather than quantitative nature. Nevertheless, they should accurately reflect the level of costs and the impact of the analyzed factors on its changes.

Material and Methods

The purpose of this research is to examine how different costs of vulcanized and adhesive splices and their different durabilities affect the costs of belting in an underground mine. The belting costs were assumed to include all costs related to the purchase and replacement of belts and to assembling vulcanized and adhesive splices. The analysis was based on several assumptions regarding the hypothetical mine in question. Firstly, the analyzed mine was assumed to have 10 km of installed belts, i.e. the conveyors have a length of approximately 5 km. Secondly, mean length of an individual segment in the loop was assumed to be 100 m. This assumption determines the number of splices. With time, as the belt is operated and subjected to wearing processes and defects, the damaged fragments are replaced by a service crew. This process leads to increased number of segments and splices. The locations in which new belt is inserted determine the number of segments and splices. The purchase costs of textile belts were assumed at 300 pln/rm. (69 EUR/rm), the costs of vulcanized joints – at 2 800 pln (643.7 EUR), and the costs of adhesive splices – 1 800 pln (413.8 EUR). Mean belt life was assumed to be 3 years. The same life was assumed for vulcanized joints, as they reach 100% of belt strength. The above fact means that vulcanized joints are replaced only when the belt is replaced and no need exists to replace them due to their deteriorated condition. With 100 splices and their life not shorter than 3 years, approximately 34 vulcanized joints will be replaced every year (34≈100/3).

Results

Calculations based on the above assumptions demonstrated that in the case of both strategies the replacement costs for belts and splices exceed 1 000 000 pln (229 885 EUR per 10 km of installed belts). The annual costs of vulcanized splices are 94 700 pln (21 779 EUR) lower than the costs of adhesive splices. The cost of vulcanized splices is 1 100 000 pln (252 874 EUR), while the cost of adhesive splices is 1 195 000 pln (274 712.6 EUR). Belt replacements account for the greatest part of these costs (90.88% and 83.66%, respectively). The annual cost of vulcanized joints was 95 200 pln (21 885 EUR) which accounted for 8.65% of the total costs, adhesive splices was 180 000 pln, (41 379.3 EUR), 15.06% of the total costs.

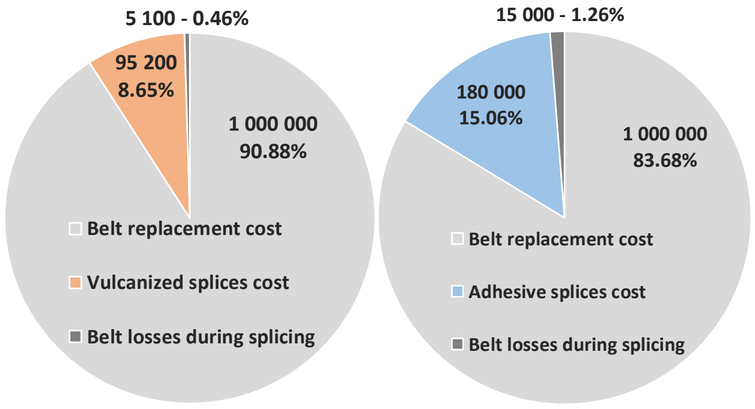

Fig. 1. Share of component costs in belt and splice replacement costs

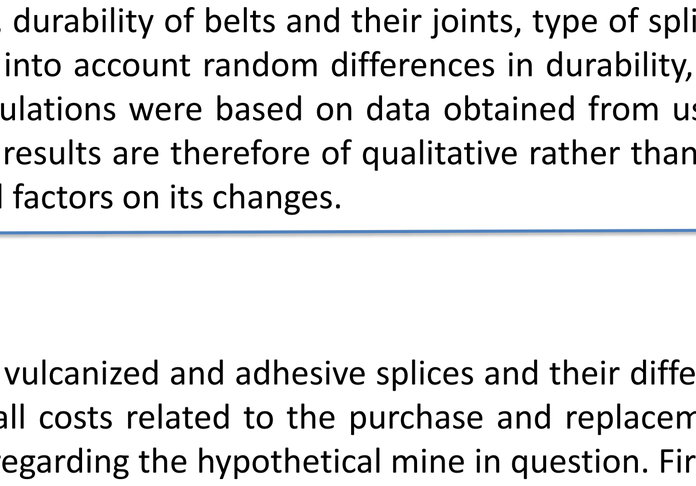

Fig. 2. Impact of mean belt segment length in a mine on belt and splice replacement costs

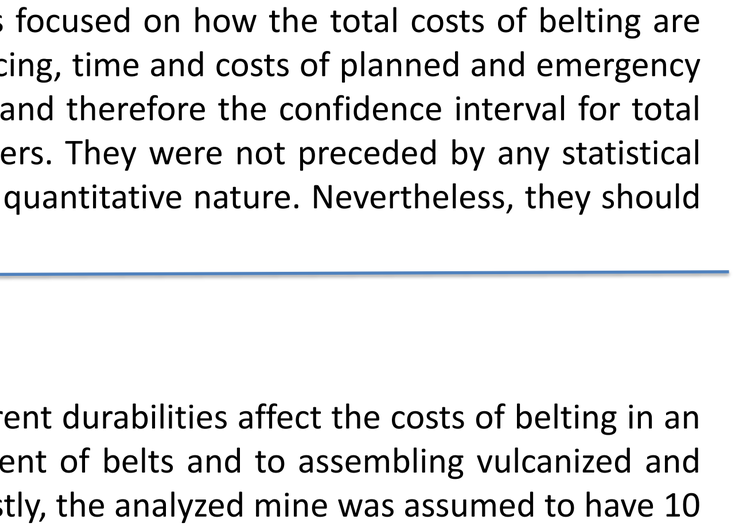

Fig. 3. Impact of average durability of adhesive belt joints on total belt and splice replacement costs

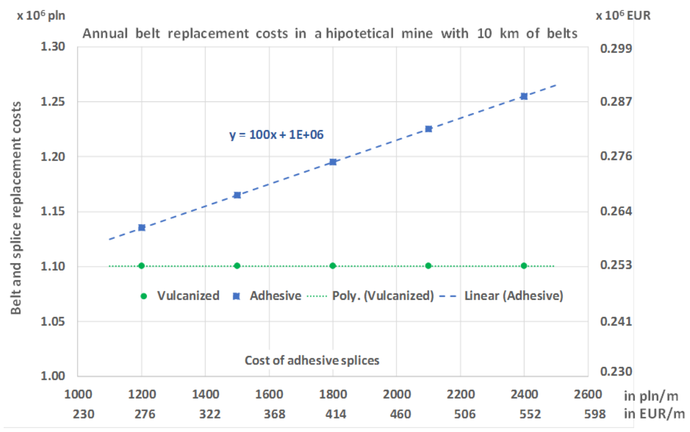

Fig. 4. Impact of the price of adhesive belt splices on the total belt and splice replacement costs

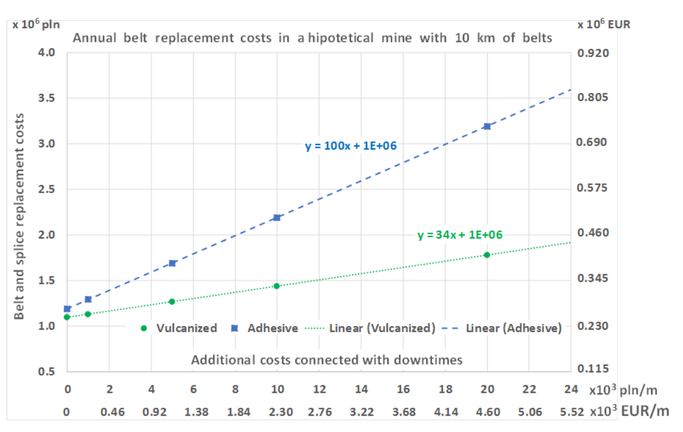

Fig. 5. Impact of the additional costs of downtimes on the total belt and splice replacement costs

Discussions & Conclusions

The analyzes confirmed that belt durability is a parameter of key importance for the annual total costs of belt and splice replacement. Mine management should pay much attention to their proper operation and monitor their wear degree. Belt durability introduces difference to the total costs in both strategies.

Although this analysis was focused on the costs for the adhesive splice and vulcanized joint strategies considered in separation, actual mines may operate both types of splices simultaneously. The actual costs may be therefore calculated as a weighted mean of costs for both strategies, based on the proportions between the two types of splices operated in the mine.

Acknowledgements

The publication was financed from the funds of a project realized under the Applied Research Programme in path A, titled "Joints of multi-ply conveyor belts with increased functional durability" No. PBS3/A2/17/2015.