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Experimental Stress Analysis

# Analysis of compressive forces on rolls of a pipe conveyor

Peter Michalik, Vieroslav Molnár, Gabriel Fedorko, Jozef Zajac, Sławomir Luściński, Michal Hatala, Peter Monka,Vladimir Simkulet, Imrich Orlovský

**Abstract:** The paper deals with the analysis of compressive forces in the rolls of a pipe conveyor measured on a testing device

**Keywords:** Pipe conveyor, Testing device, Rolls of a pipe conveyor

## 1. Introduction

In present time, among ecological and perspective systems of cyclic - flow process technology of materials, a pipe conveyor can be classified. (Fig. 1).

Pipe conveyors have found their application in all industrial sectors – mining, energy, building industry, chemistry and we cannot omit also food and agricultural sector.

**Fig. 1.** Upper and lower branch of a pipe conveyor

The main reason for the substitution of classic belt conveyors for pipe conveyors, despite the higher number of moving elements and more expensive conveyor belt, is the reduction and complete prevention of effects of transported material on environment and vice-versa. Furthermore, the structure of a pipe conveyor allows transfers on transport lines with higher incline as well as it allows the creation of transport line arches on horizontal and vertical planes.

Pipe diameter can be 110 - 850 mm and the conveyor length ranks from 40 m to 10 km. The most frequently used length of a pipe conveyor is around 150 m.

## 2. The idea

During the thirty years of the existence of the pipe conveyors, various structural malfunctions have been discovered throughout their operations that are specific for individual service operations. Only on their basis, necessary structural modifications could be realised. The most perishable elements of a pipe conveyor are a conveyor belt and transport rollers. We focus on the interaction of the conveyor belt with the rollers in laboratory conditions. The value of compressive forces is harvested by using resistance strain-gauges on a testing facility with a conveyor belt.

### *2.1. The structure of testing device*

In order to assess the interaction between the conveyor belt and rollers in the roller mill, the testing device was designed and constructed (Fig. 2) which represents a part of a pipe conveyor.

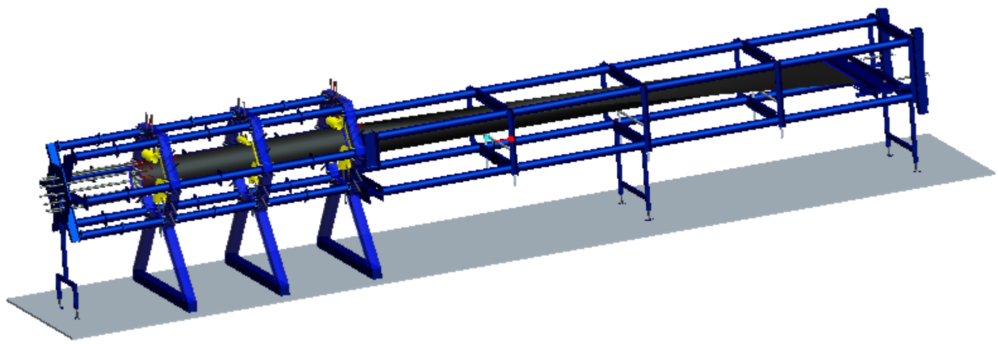

**Fig. 2.** Testing device for conveyor belts of a pipe conveyor

For positioning of resistance strain-gauges we chose substitutes of holders of a roller (Fig. 3).

**Fig. 3.** Substitute of a roller and holders with strain-gauges

**Fig. 4.** Tightening screw rod with glued strain-gauges

The tightening screws (Fig. 4) that secured the tensioning of the conveyer belt.

## 3. Measurement

Concerning the options for positioning, accuracy of measurement and even economical aspects we proposed resistance strain-gauges. We used the Wheatston's bridge connection which is the most commonly used one.

Fig. 5 shows the position of resultant compressive forces on individual rollers as well as assignment of strain-gauge bridges on individual rollers.

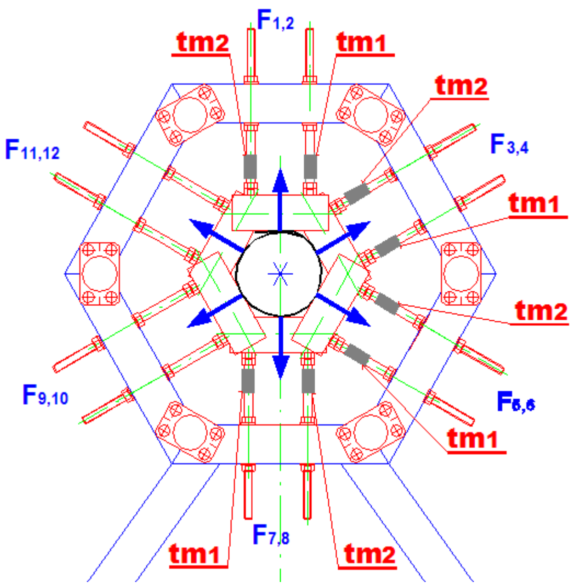


**Fig. 5.** Position of resultant force $F_{1,2} – F_{11,12}$ and assigning of strain-gauge bridges $t_{m1}$, $t_{m2}$ on individual rollers

For the performance of tests on the implemented testing device, a sample of a disabled rubber conveyor belt from the pipe conveyor of company Siderit Ltd., Nižná Slaná was used - Type EP 500/3 w.800 4+3 cat. D, for maximal stretching force $F_N$ = 15 000N.

## 4. Analysis of compressive forces on individual rolls between strain – gauge bridges $tm_1$ a $tm_2$.

On individual rolls the behaviour of compressive forces was depending up time t = 0 s to (Fig. 6. - Fig. 9). The smallest differences of compressive forces between the strain – gauge bridges on individual rolls:

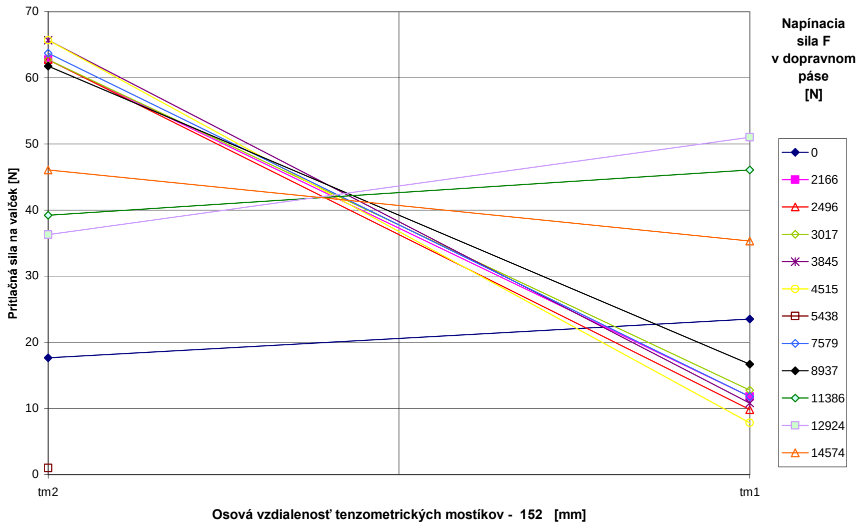


**Fig. 6.** Behaviour of compressive forces between $tm_1$ and $tm_2$ on the roll number 1 in time t = 0 s

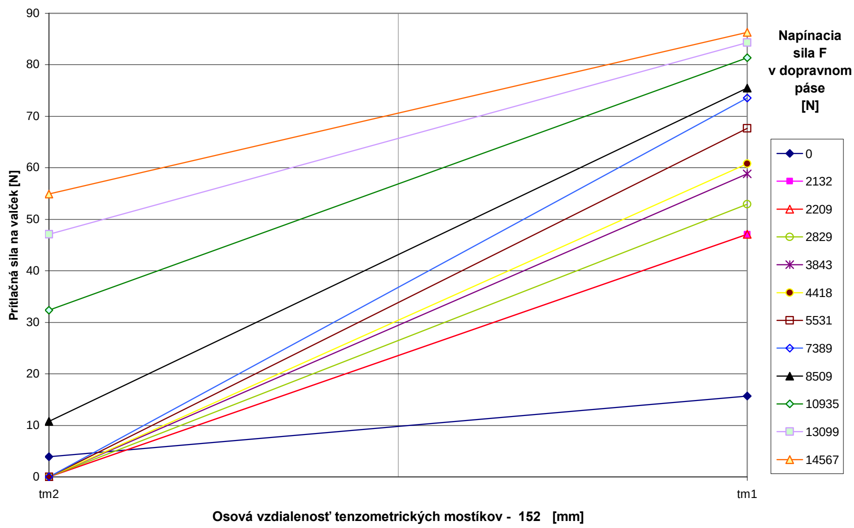


**Fig. 7.** Behaviour of compressive forces between $tm_1$ and $tm_2$ on roll number 2 in time t = 0 s

On the roll number 1, the smallest increase of $F_1$ and $F_2$ equalled 5.88 N with stretching force $F_N = 0$ N what represents 25 % from the maximum value, in the time interval t = 0 s

On the roll number 2 the smallest increase of $F_3$ and $F_4$ equalled 11.77 N with stressing force $F_N = 0$ N what represents 78.46 % from the maximum value, in the time t = 0 s

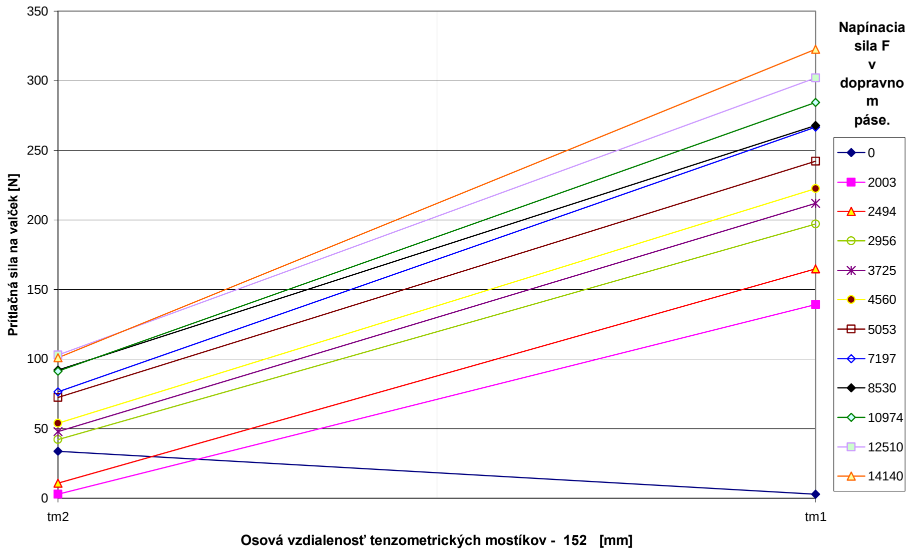


**Fig. 8.** Behaviour of compressive forces between $tm_1$ and $tm_2$ on roll number 3 in time t = 30 s

On the roll number 3 the smallest increase of $F_5$ and $F_6$ equalled 30, 8 N with stretching force $F_N = 0$ N what represents 91 % from the maximum value, in the time interval t = 30 s.

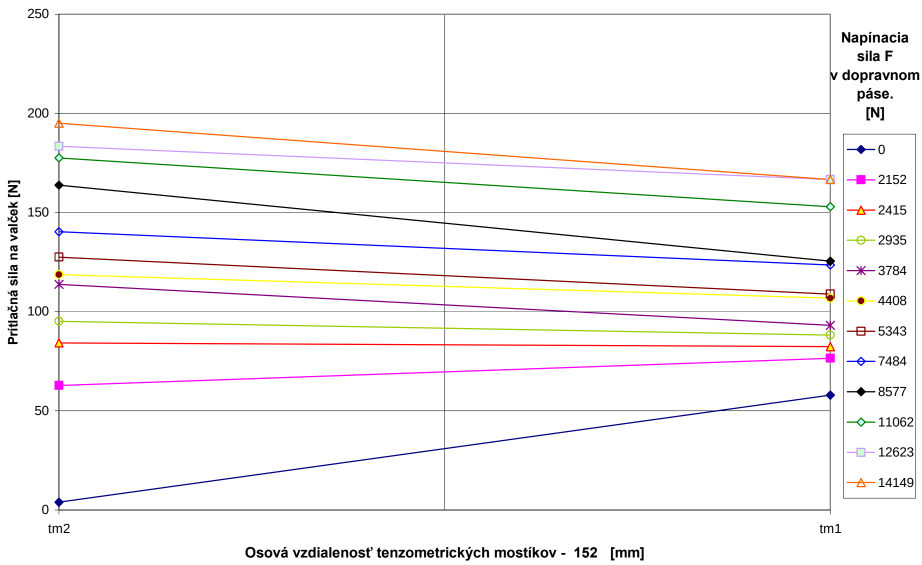


**Fig. 9.** Behaviour of compressive forces between $tm_1$ and $tm_2$ on roll number 4 in time t = 50 s

On the roll number 4, the smallest increase of $F_7$ and $F_8$ equalled 1. 96 N with stretching force $F_N$ = 2415 N what represents 2.3 %, from the maximum value, in the time interval t = 50 s.

## 5. Conclusion

The construction and control of the only recently developed device - the pipe conveyor is constantly needed to be innovated and supplemented with devices that would extend its period of working life and decrease financial expenses.

On the basis of measuring of the behaviour and strength of pressure forces on individual rolls we have discovered that it is necessary to measure and regulate the strength of the stretching force $F_N$ in the conveyor belt during the operation of the pipe conveyor. Its immediate value might be affected by the amount of transported material, curving of the line of the pipe conveyor, speed of the conveyor belt, temperature of environment in which the conveyor belt actually moves as well as the level of wear and ageing process of the conveyor belt.

Increasing the stretching force causes increase of the compressive force on the rolls of pipe conveyor too.

Added adaptive control of the strength of stretching forces in the conveyor belt of the pipe conveyor will extend the period of service of the moving elements.


## Acknowledgement

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## References


[1] Fabian, M. - Spišák, E.: Navrhování a výroba s pomocí CA.. technologií. 1.vyd. Brno: CCB, 2009. 398 p. ISBN 978-80-85825-65-7.

[2] Stanová, E.: Mathematical Expression of the Wire Axis in Trihedral Strand of Steel Rope. In: TRANSPORT & LOGISTICS, No.14 (2008), Košice, pp. 40 – 46, ISSN 1451-107X.

[3] Janecki, D; Adamczak, S.: Edge effect elimination in the FIR implementation of Gaussian filters MEASURE AND QUALITY CONTROL IN PRODUCTION Volume: 1860 Pages: 113-121 Published: 2004 Conference Title: 8th International Symposium on Measurement and Quality Control in Production Conference Date: OCT 12-15, 2004 Conference Location: Erlangen, GERMANY

[4] Kotus, M. – Žarnovský, J. – Kováč, I. – Daňko, M. – Ružbarský, J. 2009. Hodnotenie vlastností zvarových spojov dynamickými skúškami. In Nové trendy v prevádzke technických systémov ´09. Prešov : Technická univerzita v Košiciach, 2009. s.41-43. ISBN 978-80-553-0311-6.

[5] Marasová,D., Husáková,N., Grinčová,A.: Conveyor haulage optimalization in iron ore conveying - Optimizacija transportera za transport železne rude. In: Current Situation and Development of Mine Haulage and Hoisting: 7th International symposium On Haulage and Hoisting ISTI'08: proceedings. – Belgrade : University of Belgrade, 2008. - ISBN 978-86-7352-197-8. - P.49-52.

[6] IVANČO, V. - KUBÍN, K. - KOSTOLNÝ, K.: Analysis of behaviour of horizontal safety system. In: Metal Structures. Rotterdam : Millpress, 2003. s. 369-372. ISBN 90-77017-75-5.

[7] Mareš, A., Senderská, K., Fabian, M.: Optimalizácia ručného montážního pracoviska , In: Ai Magazine :Leaderpress Žilina. - ISSN 1337-7612. - Roč. 1, č. 3 (2008).