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RESEARCH AND ANALYSIS OF TECHNICAL PARAMETERS OF THE CONVEYOR BELT

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Key words: transport, belt conveyor, technical parameters

Abstract:
The most important element of a continuous transportation system is belt conveyor. Consequently, the comprehensive knowledge its major properties, and the mutual correlation among structural and technical characteristics are required for suitable selection, calculation and design of the belt conveyor. Evidence demonstrates, based on through assessment that belt conveyer technical parameters are correlated in different ways. Further, the development of the model enables optimization of the technical parameters to be used in the continuous conveyance systems. Finally, the model implementation provides useful data that can be used as a start point for the further continuous conveyance system studies.

1. Introduction

As a part of the mineral resources exploitation, the conveyance system presents various activities that utilized conveyance means, equipments and facilities. i.e., conveyance systems with goal to assure effective, low coast, and safe delivery of the mineral, slag, workers, materials, tools, equipments, spare parts, etc. The summary of all mine conveyance activities, that present conveyance system have the main goal to provide conveyance that is reliable, effective, safe and with minimum expenses. Conveyance system is a complex system, which consists of sub - systems which incorporate diverse mining conveyance elements, e.g. conveyance means, tools and equipment, facilities, communication, etc.

Means of transportation are the most important aspect of the conveyance system. Thus, the adequate selection of conveyance means significantly influence safety and cost-efficiency, and as a result has important influence on the entire mining production cost-efficiency. The most employed element of the conveyance systems is the belt conveyer. Further more, in mineral resources conveyance, increase in use of the belt conveyer in design of new systems, its incorporation in an existing systems during the revitalization and modernization practices, is evident due to its advantages when compared with other conveyance systems.

Auxiliary equipments and facilities in conveyance system are integral part of the system with main function to provide qualitative and safe mineral conveyance with minimum operational costs. The most often used auxiliary equipments and facilities elements of the continual conveyance systems are: bunkers, feeders, crushing machines, loading points, transfer points, unloading points, etc.

As a result of the expansion in development of the mineral resources continual conveyance equipments both in the surface and underground mines, intensive development and increase in utilization of rubber belt conveyers is noteworthy.

The most important element of the continual convey system is belt conveyer. Given that for appropriate selection, calculation and design, a prior comprehensive knowledge of its main characteristics and correlation among constructive and technical parameters is crucial. The significant number of technical papers that examine conveyer constructive parameters and evaluate belt conveyer characteristics are published worldwide and in Serbia. This study presents analyses of the

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specific belt conveyer technical parameters with main objective to provide practical information about correlation among belt conveyer technical characteristics.

2. Belt conveyor technical parameters examination

For the development of the mathematical model and OpTrans software, that is used for continual conveyance parameters optimization in underground mining of mineral resources, various tests and analyses of specific belt conveyer technical parameters are conducted at the Faculty of Mining and Geology, Belgrade, Serbia. Based on these approximate examinations, the selection of the belt conveyors to be applied in modeling is achieved. Further, this system technical parameters assessment enable reduction of components and types of conveyance systems varieties to be evaluated given the diversity of the components and conveyance systems available on the market.

Data used as inputs for belt conveyer technical analyses are: characteristics of the material to be conveyed, transport capacity, belt width and velocity, conveyance route length and configuration, driving drums order, tensioning device, loading and transfer point position, number and arrangement of the clearing ploughs, distance between stacks on bearing pulley and guide pulley sides, the number of motors per driving drum.

The analyses are completed for belt conveyer with steal gaskets (ST 500 - ST 6300), 800 mm and 1000 mm width, velocity 1 m/s, 1.3 m/s i 1,6 m/s, and incline angel 20^0 i $30^0$of the transporter side rolls for horizontal route, and transporter incline route of 5^0, 10^0 and 15^0. For the test and assessment the ore with following characteristics is used: maximum size is 150 and 250 mm, material incline angel under the steady condition is 35^0, material incline angel under the mobile conditions is 25^0, ore density ranging from 1930 kg/m^3 to 2410 kg/m^3. The generated output results are: belt cross section utilization rate percentage, installed engine power, belt minimum, maximum and effective stress force, (T_{min}), (T_{max}), and (T_{ef}), in a given order.

Further, analyses incorporated some additional parameters, namely, bearing pulley and guide pulley, drums, driving engine, hydraulic clutch, gearbox, and breaks. Given the volume of the study, the discussion about these additional parameters is not included n this technical paper.

Finaly, besides the major before mentioned analyses and examinations, the subsidary calculations of criteria which comprehension is significant for appropriate belt conveyor designg, selection and optimization was accomplished, i.e., computation of the ore trajectory after it commes down from the belt, the force neccesary to overcome rection force at the loading point, driving drum velocity and components , lifespan of the bearings, belt length in roll at the drum, and convex curve radius for center of wrench, tension at the belt edges, belt lift force.

The most important parameter of all conveyance means including the belt conveyer is capacity. Theoretical hourly capacity as a result of the belt width, side roles incline angle, belt velocity are presented in Table 1 and graphically exhibited in Fig. 1.

***Tab. 1** Belt conveyor theoretical hourly capacity*

Side rolls incline angel	Belt width mm	Belt velocity m/s	Theoretical capacity t/h
20^0	800	1	436
	800	1,3	566
	800	1,6	697
	1000	1	703
	1000	1,3	914
	1000	1,6	1125
30^0	800	1	505
	800	1,3	656
	800	1,6	808
	1000	1	815
	1000	1,3	1059
	1000	1,6	1304

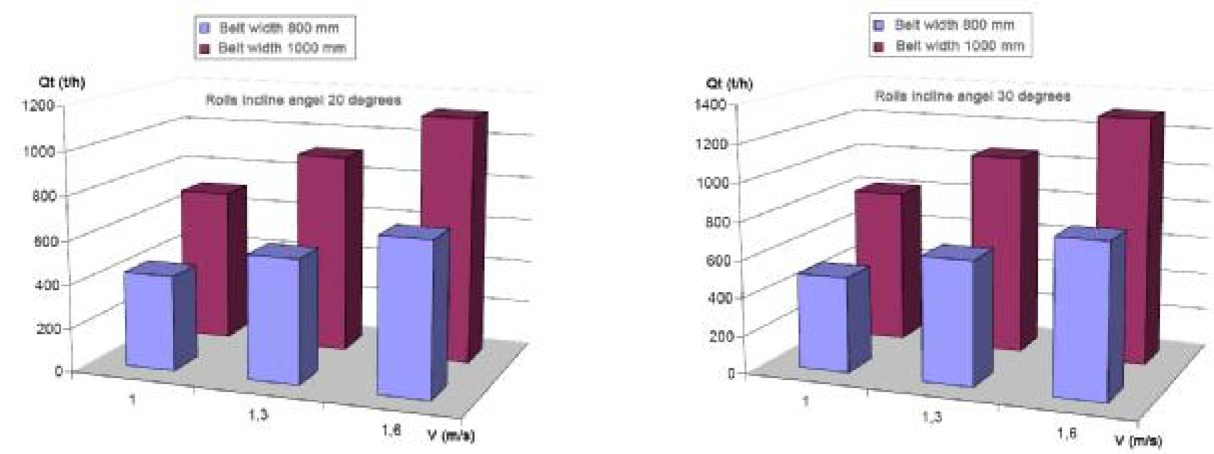

Fig. 1 *Belt conveyor theoretical hourly capacity*

Based on the results assessment it is apparent that significant quantity of the ore yields can be transported by the belt conveyers, Furthermore, the transporters theoretical capacity exceeds the designed capacity for metal and non-metal mineral resources mines in Serbia.

Examination of the designed and theoretical capacity, i.e., belt cross section utilization rate analyses, is based on the belt cross section utilization rate percentage parameters. The results are summarized and presented in Tab. 2 and Tab. 3, and in Fig. 2 and Fig. 3,respectively.

Tab. 2 *Utilization rate for the belt cross section with 800 mm widthe*

B = 800 mm, v = 1 m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	21	436
185	42	436
275	62	436
365	81	436
460	100	436
550		436
B = 800 mm, v = 1.3m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	16	566
185	33	566
275	49	566
365	64	566
460	81	566
550	97	566
B = 800 mm, v = 1.6m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	13	697
185	27	697
275	39	697
365	52	697
460	66	697
550	79	697

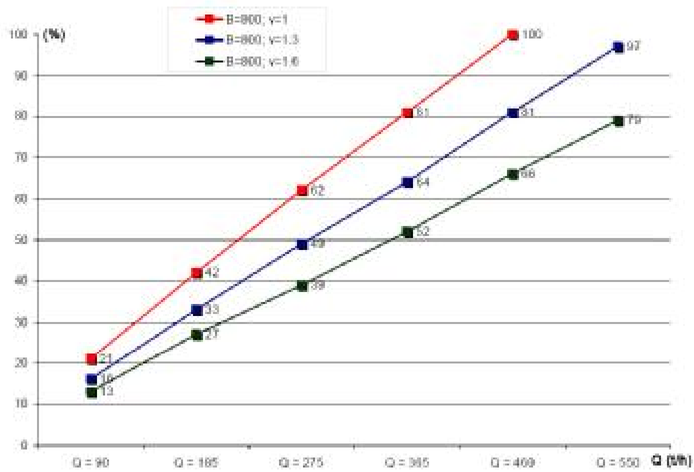

Fig. 2 *Belt capacity percentage B = 800 mm and b = 20^0*

Tab. 3 *Utilization rate for the belt cross section with 1000 mm widthe*

B = 1000 mm, v = 1 m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	13	703
185	26	703
275	39	703
365	52	703
460	65	703
550	78	703
B = 1000 mm, v = 1.3m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	10	914
185	20	914
275	30	914
365	40	914
460	50	914
550	60	914
B = 1000 mm, v = 1.6m/s, b = 20^0		
Designed capacity (t/h)	Belt cross section capacity (%)	Theoretical capacity (t/h)
90	8	1125
185	16	1125
275	24	1125
365	32	1125
460	41	1125
550	50	1125

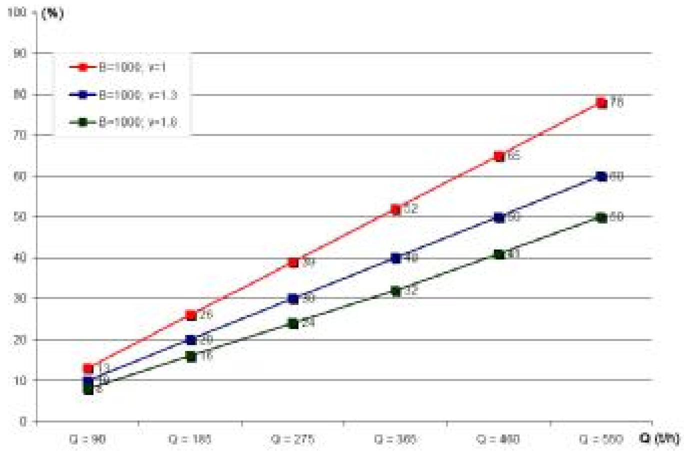

Fig. 3 *Belt capacity percentage B = 1000 mm and b = 20^0*

Based on the results introduced in above tables and figures, i.e., belt width 800 and1000 mm, capacities of 90, 185, 275, 365 460 and 550 t/h, side rolls incline angel 20^0 , and velocity of 1, 1.3 and 1.6 m/s, it is noticeable that for the belt cross section capacity of 90, 185 i 275 t/h utilization rate is very low, while the 50 percent utilization rate is reached for the belt cross section capacity of 365, 460 and 550 t/h. Thus, it can be deduced that during the selection of belt conveyer logical parameters, it is crucial to consider that the design capacities in Serbian mines are bellow the significant conveyance capacities of the belt conveyers.

Transporter length is addition important technical parameter that should be included in the belt conveyer technical assessment. Particularly, in underground exploitation the length of the belt is closely related to the conditions in those mines, e.g. variety of the transportation trajectories, frequent direction and angle changes, hard working and maintenance conditions, etc. As a result, assessment were completed for different capacities, conveyance length, and conveyance trajectories angles the analyses of the maximum stress force for the belt with wire rope, type ST. The evaluated belt have width 1000 mm, velocity of 1 m/s, and capacities of 365, 460 and 550 t/h, for horizontal routes and routs with angels of 5, 10 and 15^0. Generated results introduce remarkable directions with respect to the conveyance route length limits as a function of the conveyance capacity and maximum belt tension. The results are demonstrated and shown in Tab. 4, Tab. 5, Tab. 6 and Tab. 7 and Fig. 4, Fig. 5, Fig. 6 and Fig. 7, in a given order.

Tab. 4 *Maximum belt tension for horizontal conveyance route*

Conveyance length (m)	Maximum belt tension (kN/m)		
	Q=365 t/h	Q=460 t/h	Q=550 t/h
300	22.14	24.23	28.63
600	37.80	46.23	52.34
900	55.14	63.20	73.19
1200	69.44	81.50	95.32
1500	83.86	99.74	114.77
1800	98.48	117.57	133.99
2100	112.42	133.28	153.00
ST belt conveyors application based on breaking hardness criterion			
300	ST 500	ST 500	ST 500
600	ST 500	ST 500	ST 500
900	ST 500	ST 500	ST 500
1200	ST 500	ST 630	ST 800
1500	ST 630	ST 800	ST 800
1800	ST 800	ST 800	ST 1000
2100	ST 800	ST 1000	ST 1250

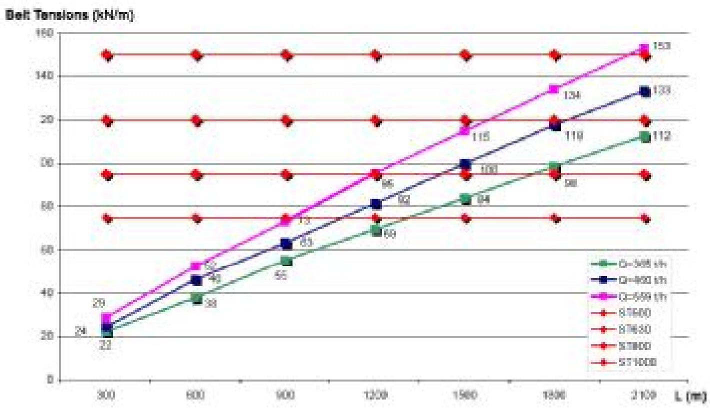

Fig. 4 *Maximum belt tension for horizontal conveyance route diagram*

Tab. 5 *Maximum belt tension for conveyance route with angles of 5^0*

Conveyance length (m)	Maximum belt tension (kN/m)		
	Q=365 t/h	Q=460 t/h	Q=550 t/h
300	72.38	89.48	106.18
600	142.37	178.8	210.02
900	209.16	259.7	306.51
1200	279.81	350.57	414.95
1500	353.07	438.29	520.9
1800	424.54	529.86	648.33
2100	501.24	656.23	752.75
ST belt conveyors application based on breaking hardness criterion			
300	ST 630	ST 800	ST 800
600	ST 1000	ST 1250	ST 1600
900	ST 1600	ST 2000	ST 2500
1200	ST 2000	ST 2500	ST 3150
1500	ST 2500	ST 3150	ST 4000
1800	ST 3150	ST 4000	ST 5000
2100	ST 4000	ST 5000	ST 6300

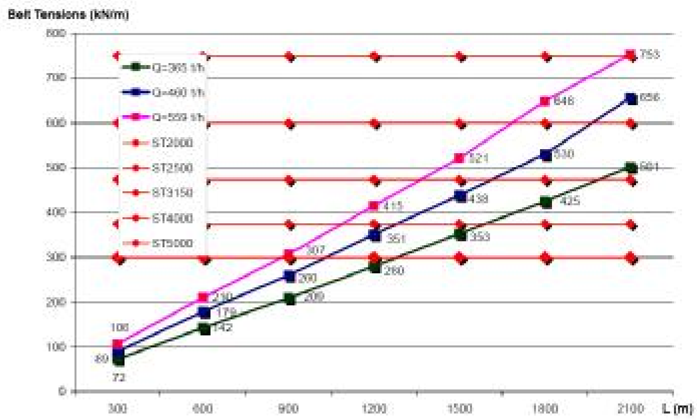

Fig. 5 *Maximum belt tension for conveyance route with angles of 5^0*

Tab. 6 *Maximum belt tension for conveyance route with angles of 10^0*

Conveyance length (m)	Maximum belt tension (kN/m)		
	Q=365 t/h	Q=460 t/h	Q=550 t/h
300	100.19	125.71	148.08
600	195.21	244.46	288.67
900	293.46	367.23	436.61
1200	393.67	493.61	584.46
1500	496.41	656.42	744.7
1800	595.17	774.93	866.55
2100	722.11	883.52	
ST belt conveyors application based on breaking hardness criterion			
300	ST 800	ST 1000	ST 1000
600	ST 1600	ST 2000	ST 2000
900	ST 2000	ST 2500	ST 3150
1200	ST 3150	ST 4000	ST 4000
1500	ST 4000	ST 5000	ST 5000
1800	ST 4000	ST 6300	ST 6300
2100	ST 5000	ST 6300	-

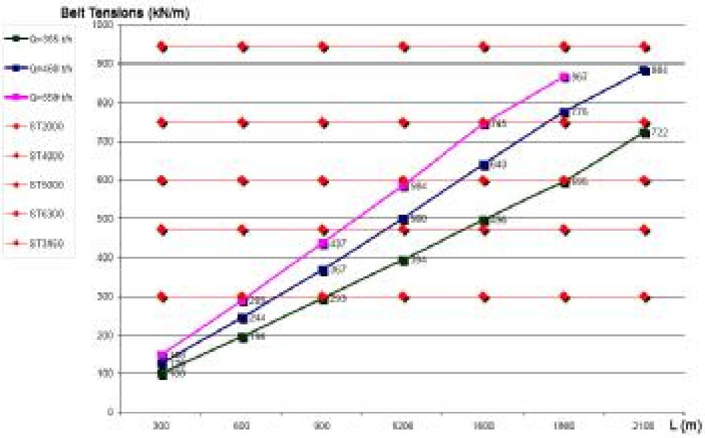

Fig. 6 *Maximum belt tension for conveyance route with angles of 10^0*

Tab. 7 *Maximum belt tension for conveyance route with angles of 15^0*

Conveyance length (m)	Maximum belt tension (kN/m)		
	Q=365 t/h	Q=460 t/h	Q=550 t/h
300	166.95	208.72	245.87
600	330.17	412.3	494.2
900	497.92	659.45	-
1200	676.87	851.31	-
1500	857.44	-	-
1800	-	-	-
2100	-	-	-
ST belt conveyors application based on breaking hardness criterion			
300	ST 1250	ST 1600	ST 2000
600	ST 2500	ST 5000	ST 4000
900	ST 4000	ST 6300	-
1200	ST 5000	-	-
1500	ST 6300	-	-
1800	-	-	-
2100	-	-	-

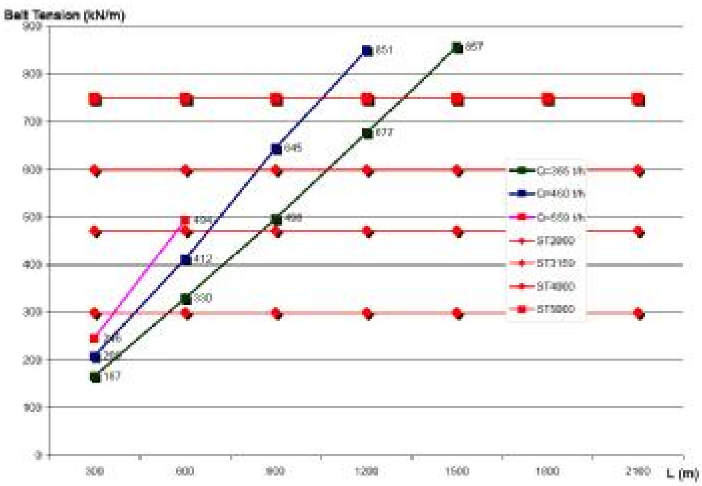

Fig. 7 *Maximum belt tension for conveyance route with angles of 15^0*

It can be concluded that for the evaluated technical parameters at the horizontal conveyance routes belts type ST 500 – ST 1250 for all assessed conveyance routs are suitable. On the other hand, for conveyance route with angles of 5^0, 10^0 and 15^0, application of the ST rubber belts with wire rope is limited by breaking points associated with stress force since it can not fully met required maximum belt tension benchmarks. Thus, for those lengths, either other type of the belt or more conveyers should be applied to achieve required utilization conditions.

3. Conclusions

Specific and hard conditions in the mines for minerals underground exploitation and the type of the minerals are the main limitation causes of the continual conveyance systems application, e.g. coarse parts existence that requires use of the primary crusher and feeder, increase in dust conditions due to the presence of immense amount of abrasion mineral dust, increase in rubber belts wear as a result of abrasive and coarse parts conveyance, long conveyance routes length, uneven conveyance routes (horizontal and vertical curves), etc.

Evaluation and analyses of the belt conveyer technical parameters is significant and integral part of the continual conveyance systems parameter optimization model for mineral resources underground mines. Computation and selection of the suitable conveyer parameters is a complex procedure that incorporates significant number of criteria, from transporters components and parts selections and calculations, to selection of the most appropriate conveyance type. Prior to conveyer constructive elements calculation and design, the comprehensive analyzes of the various technical parameters has to be completed. In this way, selection and computation of the continual conveyance systems constructive and technical parameters would fulfill all conditions and requirements for the conveyance systems in underground exploitation of the mineral resources.

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