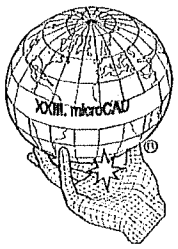

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OPTIMIZATION METHODS WHICH CAN BE USED AT WIRE ROPE PRODUCTION (COST AND TIME)

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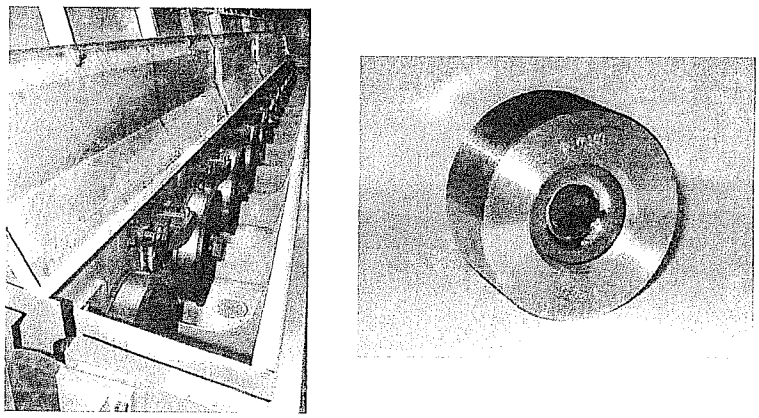
ABSTRACT

The aim of this paper is to give some useful analytical methods for optimization of wire ropes. After the introduction of common wire rope production, the parameters are defined. The selection of parameters is the next step and the mathematical formulation of their effect. The right solution would be the optimized rope for cost and/or time.

INTRODUCTION

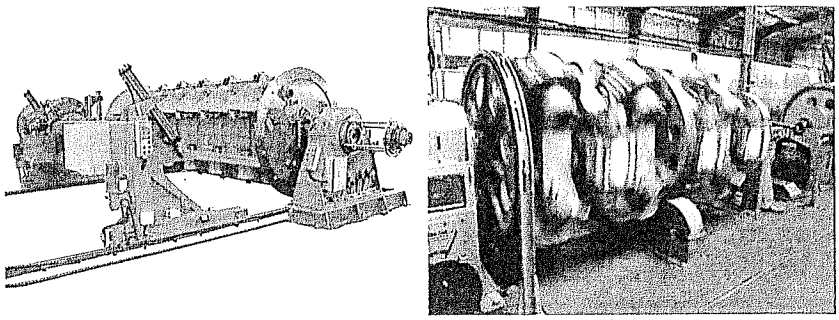
The wire rope production can be optimized if all of the steps are well known. In this paper, the most common wire ropes will be analyzed, so compacted strands or plastic core and other wire rope with special properties will be not examined by this article [1]. The common wire rope production consists of 3 main steps. The first step is the drawing of the wire to the right diameter. Drawing dies are used to decrease the diameter of the wire rope. A drawing machine and a drawing die can



a, b,

Figure 1. A drawing machine (a,) and a drawing die (b,)

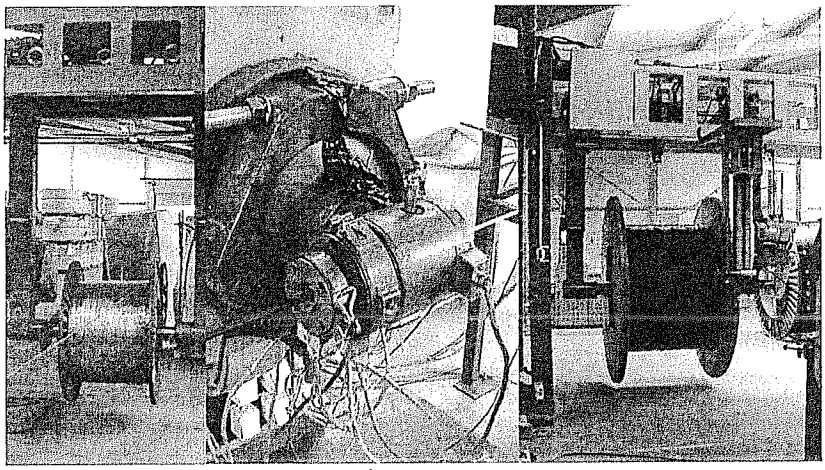
be seen in Figure 1. On the market wires with variable diameter can be bought but a lot of money can be spared, if the production contains the drawing itself too. The second main step is the twisting. By twisting there are usually used once, twice or more times twisted constructions according to the demand of the industry.



a, b,

Figure 2. A wire rope twisting machine (a,) and another wire rope twisting machine in production (b,)

A twisting machine and a twisting machine in production can be seen in Figure 2. The last step is the extrusion of a wire rope with a cover. The cover gives special properties to the wire ropes, such as: sealing, mechanical protection etc. The method of the extrusion can be seen in Figure 3. With these steps a common wire rope can be produced, but more processes are needed to get better common wire rope. Usually there are several more steps which are needed by production such as: usage of pre-forming head, after-forming roller row, calibre roller, greaser or lubricators. The usage of pre-forming is helping to produce stress-free wire ropes. To repair the failures of the correct twisting and to reduce the remained stress in the produced wire rope an after-forming is required. With a correct pre- and after-forming better wire rope can be produced. Wire ropes with fibre core after production sometimes have not the waited diameter because of the tolerance of the standards.



a, ,b c,

Figure 3. Normal wire rope on drum (a,), extrusion process with extruder head (b,), The covered cable on drum (c,)

The fibre core is enough soft to re-form with calibre roller to the right diameter. Nowadays one of the most important steps is the lubrication or the greasing of the wire ropes because the lifetimes can be increased easily.

PROBABLE PARAMETERS OF THE WIRE ROPE PRODUCTION

There are several parameters, which have great influences to the speed, time and the costs of the wire rope production. In Table 1 these main parameters can be seen. The first step is the drawing. The first parameter in this column is the diameter. The diameter consists of two parts. The first part is the starting diameter and the second is the drawn diameter. If the difference is enough large, then more drawings are necessary. This number defines the number of drawings. By normal drawing machine a lot of continuous drawing can be set up, but sometimes 2 or more stages are needed to get the target diameter. There are several idle times exist too, for

Table 1.
The probable parameters of the optimization whose have the greatest influence of the wire rope production.

	Drawing	**Twisting**	**Usage of**	**Extrusion**
P1	Start diameter / Target diameter	Winding	Pre-forming head	Raw material
P2	Number of drawing stages	Diameter	After-forming roller row	Diameter of the wire rope / Diameter of the cover
P3	Dead times	Construction	Calibre roller	Dead times
P4	Speed of the machine	Number of wires	Greaser or lubricators	Speed of the machine
P5		Core	Dead times	
P6		Dead times	Speed of the machine	
P7		Speed of the machine		

example the change of the drawing dies, reel change etc. The final costs and the final quantity of the drawing are depending on the speed of the machine. In the second column the main part of the wire rope production can be seen. Before the twisting some preparation is needed what is for example winding to the right bobbin. The twisting machines use standard bobbins. The diameter of the wire rope or the individual wire have great effects to the speed, because only less quantity from the thicker wire can be winded to the same bobbins. The construction could be once, twice or more times twisted which defines the basic times of the wire rope. The core could be fibre strand, an individual wire or another steel strand. There are a lot of dead times here too, such as: welding of the wires or change of the bobbins,

etc. The pre-forming, after-forming roller row or calibre roller can be used by twisting together, so they do not need always more times. The inner lubrication can also be used by twisting. The outer lubrication usually follows the twisting so it needs more time. In this case the speed of the machine defines the base times. In the last column the parameters of the extrusion are defined. The speed is basically depending on raw material and thickness of the cover. A thicker cover needs more time to cool down. The idle times and the speed of the machine have great influences, as it was mentioned previously.

OPTIMIZATION METHODS AND AIMS

An optimization is required to produce the wire ropes with cover in a good time and for low costs. These aims are too common, so the final results can not be given easily. An optimization can be made according to the chart what can be seen in Figure 4 [2]. In the chart the first task is the definition of the problem. We have

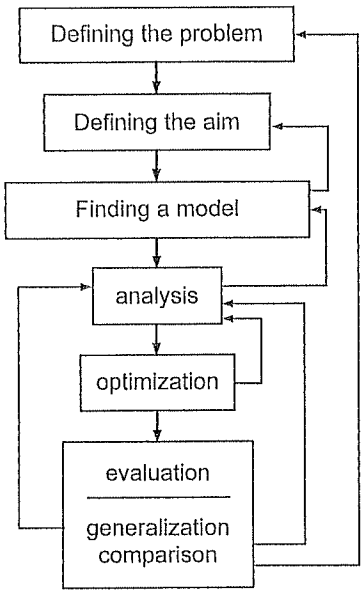


Figure 4.
The general chart of the optimization

defined the problem above. But later a much more correct definition is needed. The second step is the definition of the aims. In our case one aim could be the time and another one could be the costs of the production. The third case could be the optimum from aspect of both: cost and time. The most important step is to find the right model, because the final solution is coming from the right model [3]. The analysis, optimization, evaluation, generalization and comparison would be solved with MATLAB Software. The MATLAB Optimization Toolbox knows several

various optimization methods, but first the introduction of some questions by a model is necessary. The optimization model can be seen in Figure 5. By an optimization there are a lot of questions which have to be answered. Groups of questions can be seen in Figure 5 too. For example the variable parameters could be

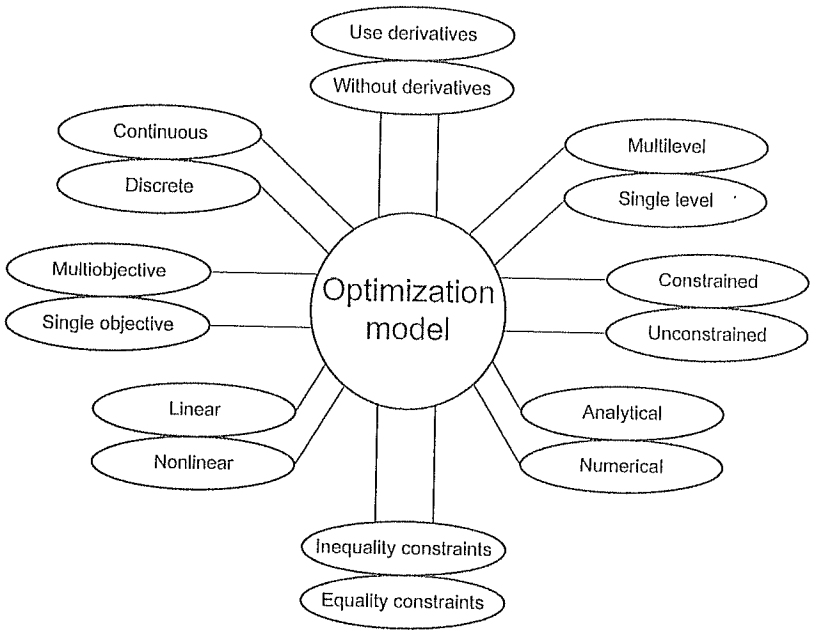


Figure 5.
The main parts and questions of the optimization model.

linear or non linear, so other optimization algorithm is better by every possibilities.

CONCLUSION AND FURTHER STEPS

The production of individual wire, the twisting and the extrusion are shortly introduced. There are several parameters which have great influences to the time and cost of wire rope production. The main chart of the optimization method was defined. To find the best optimization model a lot of questions were introduced.

The first further step is the definition of the optimization method. With the optimization method and the parameters a MATLAB program is going to be written. There are several norm times and quantities from production, so this information will be used to get further results. At first the reduction of the parameters could be a good start.

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