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DECISION MAKING DURING THE MAIN SHAFT'S OPTIMIZATION OF WINCH HAULAGE

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ABSTRACT
In this paper the optimization model of the main shaft of winch haulage is analysed. The approximate mechanical model is built based on 'real' shaft taking into consideration the loads and shaft's behavior in relation to stability and stiffness criteria. The volume of shaft is defined as an objective function subjected to the angle of torsion, safety coefficient, deflection and displacement, and shaft geometry as constraints at optimization model. The phases of design, from building the mechanical model to the evaluation are elaborated from the aspect of decision making, trying to achieve best 'phase result'.
Making a decision for a designer implies the consideration of a number of constraints and criteria during the evaluation of the set of solutions. Therefore, at each phase during optimal design of shaft was considered the decision making methodology that includes four concerns: Task (T), Alternatives (A), Evaluation (E) and Challenge(C).
The 'optimal solution' of the adopted model was found with Optimtool of Matlab software. Comparison with 'real' dimensions showed that results are satisfactory and good base for deeper research.
Key words: Decision Making, Shaft of Winch Haulage, Stability and Stiffness Criteria, Optimization Model, Optimal Solution, Deflection and Displacement.

1. INTRODUCTION

Constructive parameters of shaft that must be fulfilled in order to complete the working criteria are: shaft sizes, rotation moment, safety coefficient, angle of torsion, displacement of shaft and critical number of rotation.

The selection of the optimum shaft model should also fulfill constraints in order that: the shaft must be in function of winch haulage, and its installation must provide given functions.

Shaft as a part of winch haulage should also execute technical conditions towards: the other parts of winch haulage, coefficient of usefulness, and the safety coefficient.

Its design process presents a "provocation" and "challenge" for an engineer – designer/constructor, who among many tasks needs to make many decisions for getting "the best" solution.

The design is a process with many questions coming up one after another, starting from problem/task introduction, design process itself and those related directly to technology or science. The designer needs to think, wonder and decide when solving design problems. This complex task should be put through a procedure/methodology with certain stages that can be used during all design process with needed accuracy that will bring to successful finalization of the design.

In the paper is described the decision making theory and its appliance during the all phases of a design process. An adopted methodology of decision making has been adopted and applied in depth during the design process of winch haulage, starting from the dynamic and mathematical model under relevant criteria and constraints, its simulation and optimization and analysis of the behavior of winch haulage pre and after optimization.

2. DECISION MAKING IN DESIGN PROCESS

Solving the problem during the process of designing, for the designer arises a number of question such are:

- Where to start? What is the procedure?
- Is it new or former/existing design?
- Can be followed procedure from manuals or standards?
- What is a procedure for making a new design?
- How to define design problem and set design goal?
- What are quantities and what variables – free or dependent?
- How do we set constraints?
- How each item designed looks/should look in drawings?
- What shape and structure would have a product based on a design?...[3]

These and many other questions are related to technology or science but most of them are about the design process itself.

Less "creativity" is needed if design problem is "old" or "former" design. In these cases start of design is

known, only the "design procedure" needs to be followed and it easy to complete the design.

In creating the "new" design, there is no sample, no manual and no former design. The engineer – designer has to produce and decide on everything by himself. He must take into account geometry (dimensions, shape), structure (material), functionality and constraints (technical, economic, social, environmental, ethical etc.). So, the way how/what decisions are made are of most importance.

The decision concerns on:

- Carefully definition of design problem
- Searching and generating for alternatives
- Selecting the best based on evidence
- Making sure by checking that the best has been chosen

This four concerns would be adopted respectively as Task (T), Alternatives (A), Evaluation (E) and Challenge(C) and would represent the adopted methodology named TAEC and will be used on elaboration and analysis of design process of winch haulage as a case study.

3. CASE STUDY: OPTIMAL DESIGN OF WINCH HAULAGE

The TAEC methodology on decisions is due to be used in all phases of the process of design presented in general form as in fig.1. It is understandable that engineer – designer must make a right decision at each phase before continuing to next one, otherwise must return back and do searching and checking for the reasons why phase solution is not the best or right one (iteration).

In this paper as a case study is elaborated optimal design of winch haulage. Knowing shaft as a part of winch haulage should also execute technical conditions towards: the other parts of winch haulage, coefficient of usefulness, and the safety coefficient.

Based on decision making adopted methodology for decision making and above mentioned characteristics of the problem on case study, can be noticed that design process of shaft can be modified to optimal design of shaft, or as a case in which intention is optimization of some quantities or dimensions of the winch haulage model under set criteria.

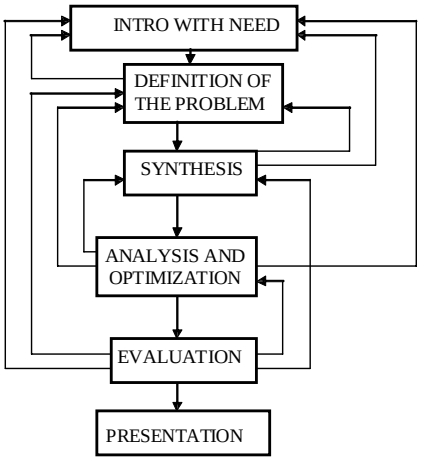
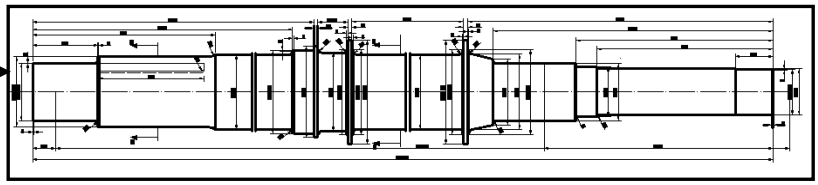


Figure 1.

INTRO WITH PROBLEM

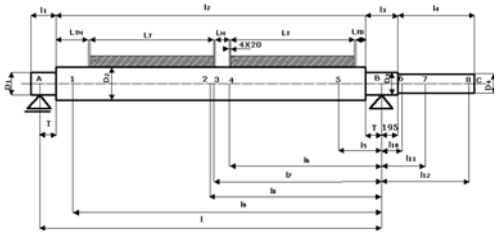


DEFINITION OF DHE PROBLEM

T- Searching and analyzing the drawings for the case problem-winch haulage helping to define it in the best way
A- Elaborating different alternatives it is decided for optimisation of non standard dimensions [1, 2, 3, 4,]
E- Dimensions/ variables will be found for the minimum lamina's surface [1, 2, 3, 4,]
C- Checking do mathematical model is correspondent to adopted dynamic model

SYNTHESIS

T- Grouping the similar existing problems
A- Comparing different groups with our problem defined in previous phase
E- Adopting the mechanical model and setting mathematical model based on it
C- Making drawings and algorithm for adopted models



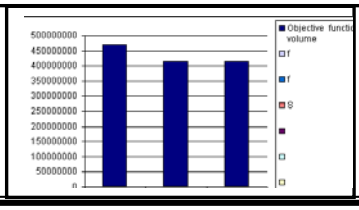
ANALYSIS AND OPTIMIZATION

T-Building optimisation model after analyzing dynamic and mathematical models
A- Searching for methods of optimization which will bring to "the best" solution (non - linear constrained optimization methods)
E- Comparing the results for optimal solutions
C- Finally, deciding for the more efficient method and software to be used

EVALUATION

T- Verification of the quantities that are not directly subject of optimization problem, but that are criteria of functionality for optimal solution (critic number of rotation, displacement, eccentricity, etc,)
A- If criteria are not satisfied, the new alternatives need to be found
E- Simulation of the solution, is it satisfactory? Yes!
C- Is simulation enough for final decision or prototype is needed to be manufactured?

Values of	D_1	D_2	D_3	D_4	l_2	S	φ	f	Objective function - volume
model	280	360	280	240	3787.5	1.866794	0.007934	17.57546	471365190.1
optimal	279.65	334.639	279.654	240.274	3729.867	1.499404	0.008841	13.11552	413880335.4
adopted	280	335	280	240	3730	1.504262	0.008834	13.22399	414611729.7



PRESENTATION

Fig.2 The TAEC methodology for optimal design of winch haulage

The optimal design of winch haulage does not present “a new” design, but it is based in existing type of winch haulage. Despite that, a number of very important decisions need to be made during the adopting dynamic/mechanical model and as well as on building mathematical model (phases at fig.2), which depends on a big number of constraints and criteria, taking into consideration rotating shaft’s deflection and stresses, and the influence of mechanical, electric and magnetic quantities.

4. CONCLUSION

Based on the shaft calculations criteria, optimal construction, analysis of optimization method, and the optimization of shaft parameters with MatLab software we can conclude that:

- the optimal construction process opposite conventional process present the most important process during the optimization of parts and machinery systems.
- the shaft optimization is realized through MatLab software, where the objective function and constraints are defined.
- the realized results on the optimal parameters of the Winch Haulage show that the objective given in this paper is achieved, because optimal sizes are achieved through preliminary sizes.

5. REFERENCES

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