CONSTRUCTION DESIGN AUTOMATICALLY ADJUSTABLE MECHANISM FOR CRANE FORKS

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Abstract
The article deals with the design of the part construction automatically adjustable mechanism for crane forks. In order to solve in the creation of solutions, the TRIZ method was used. Thanks to which managed to construct the optimal design solution. Automatically adjustable mechanism comprises a and at the same time provides the load-bearing part of the for crane forks. Design proposal and its creation was based on the entry requirements so as to be able to in terms of safety and in terms of functionality to serve its fundamental role in the operation.

Key words: *structural design; mechanism; optimization; a defensive role calculation.*

INTRODUCTION

The issue of construction and structural design of crane forks has led to entirely new dimensions thanks to current possibilities of software tools and manufacturing technology. Currently include crane forks for essential accessory lifting techniques. Its primary function is to facilitate and simplify handling of heavy loads. The current trend in the field of development of techniques is directed to the continuous improvement of individual elements of the product. The crane fork is currently supplied on the market in multiple versions and parameters, which allow for the aid of a crane transport materials and semi-finished products on pallets in production and storage areas. Some of the key structural elements ensures safety and stability while loading and moving materials. The current trend in development and innovation covers also this area of technology, it results from the continuous increase in the claims of the final consumer but also the growing competition in the market. Therefore, it is necessary to constantly work on improvements, whether structural or mechanical parts of this type of equipment. It is necessary to constantly improve production technology and to consolidate manufacturing costs in accordance with the resulting in the desired effect. When creating the design was based on the use of proven methodology triz, which forms the basis for the creation of new innovative solutions and allows the right mix of innovative principles under given conditions. This well-known methodological princip was applied in particular in the optimization of the weight of the construction of the mechanism for meeting certain strength, stiffness and functional properties of the mechanism. The solutions apply to the system the correct combination of options of the material used, manufacturing technologies and the use of appropriate computer software techniques. Our ultimate solution was preceded by several draft variants from which after thorough analysis and evaluation of chosen the very best. (Jedlinski, Caban, Krywonos, Wierzbicki, & Brumercik, 2016)

Fig. 1 The design of the crane forks of the load capacity 2000 kg

MATERIALS AND METHODS

The methodological procedure of Triz in the creation of the design:

- Select the area or object of innovation and an automatically adjustable mechanism of concrete hanging eye
- Data collection and subsequent evaluation of information about the upgraded facility, which are necessary for further solution
- Functional cost analysis of the upgraded object, where was carried out the analysis of the elements, structures, functions and parameters of the mechanism.
- Advanced diagnostics functionality, costs, and problems individual elements of the mechanism and their links to other parts of the structure
- Innovation object for the purpose of reducing the weight and thereby the total production costs
- Development of the object for the purpose of improving the strength properties and its functionality
- Selection and verification of variants
- Dizajn, test, CAD a CAM (Martikan, Brumercik, & Bastovansky, 2015)

The nature of the construction is weld – frame part and then mounted – automatic adjusting mechanism, whose task is the automatic positioning of the centre of gravity of the lifting of the preparation in two basic working positions. The first working position of the loading of the preparation is in the condition unloaded by using the transported load and the second working position is in a state loaded with the transported load.

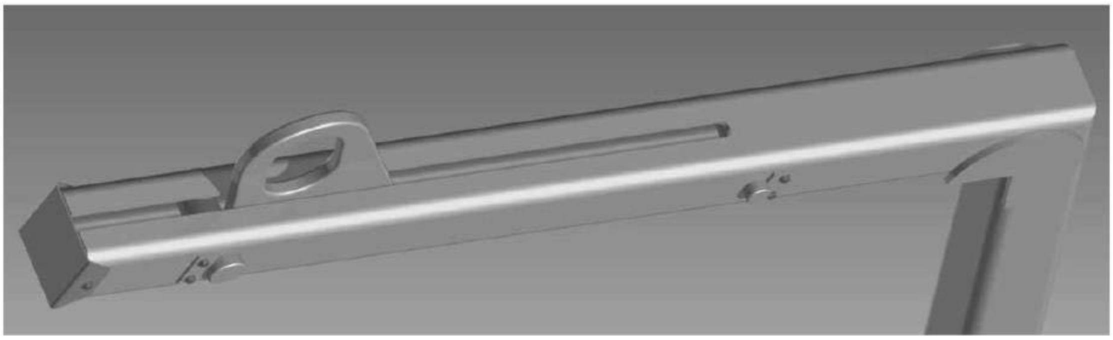

Fig. 2 The detail of the construction of the automatic setting mechanism of the crane forks

Construction of a suspension mesh has the character of the welded part, which is formed by a steel plate and two steel bolts. Steel plate is of a material 11 500 S235J0 (Shigley, Mischke, & Budynas, 2010). The thickness of the plates is 25 (mm). After made a plate, it is necessary to additionally process edges in the sense create rounded edges all the external and internal peripheral edges of the both sides of the radius 5 (mm).

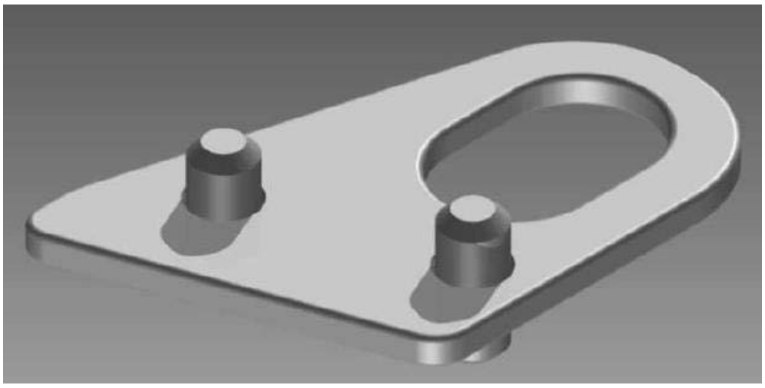

Fig. 3 The detail of the construction of a suspension mesh

In places the assumption of the occurrence of the concentration of the voltages was softened by the network. Load force FZ was to simulate touching the hook on the inner surface of the eye. Its location was realized on the part of the hole of the mesh, where it is to the point of contact of the hook. The action of the reaction forces is shown in the area of the edges of the both pivots of each of the parties. In these places is expected of the reaction forces coming from the total burdensome forces. (Sága, Vaško, Kocúr, Tóth, & Kohár, 2006)

The input attributes a strength of the analysis:

- The size of the total force FZ = 22 (kN)
- The size of the reaction force in the stub RA = 5,5 (kN)
- Material steel 11 500 (S235J0)
- Ultimate tensile strength Rm = 470 (MPa)
- The characteristic stress Re = 245 (MPa)
- Allowed voltage Thrust/Pressure σD = 140 (MPa)

RESULTS AND DISCUSSION

After the preparation of the design of the mesh, it was necessary to verify the accuracy of the optimized solutions in terms of strength and stiffness. The preparation of the model and subsequent calculation was implemented in the environment of the program Autodesk Inventor Profesional. The formation of a 3D model is managed more closer to reality. The Model is an assembly consisting of welded link parts, which are formed of a plate and two cylindrical pins. Attachment of the mesh or boundary conditions i entered as the zero offset of the respective nodes. The result of the analysis is that the largest concentration of the tensions is precisely in the area of the upper part of the plate mesh, where there is a contact surface of the eye and the hook. (Sága, Vaško, Kocúr, Tóth, & Kohár, 2006)

Tab. 1 The resultes of the analysis

Material	Displacement mm	Stress von Mises MPa
Steel 11 500 (S235J0)	0.0662	118,5

The resulting maximum tension is 118,5 (MPa), which is suitable because of the total permitted tension according to the selected type of material. Another result of the analysis is the total displacement, which is again the largest in the area of the top part of the plate mesh, where the maximum calculated value in the program achieves less than 0.07 (mm) which is from the point of view of the standard (DIN EN 13155 A2) is admissible and compliant. In the overall solution of the system is also necessary to mention the fact that the final effect depends also on the accuracy of manufacture and also at the final operating environment. (Sága, Vaško, Kocúr, Tóth, & Kohár, 2006)

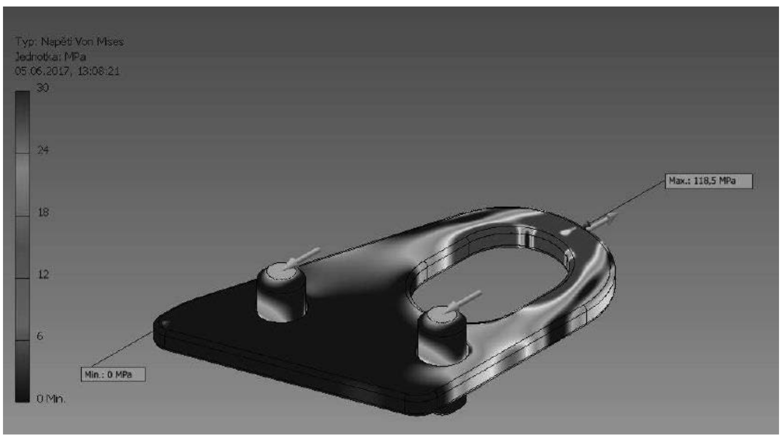

Fig. 4 The calculation of over tensions in the program Autodesk Inventor Profesional (Tension von Mises)

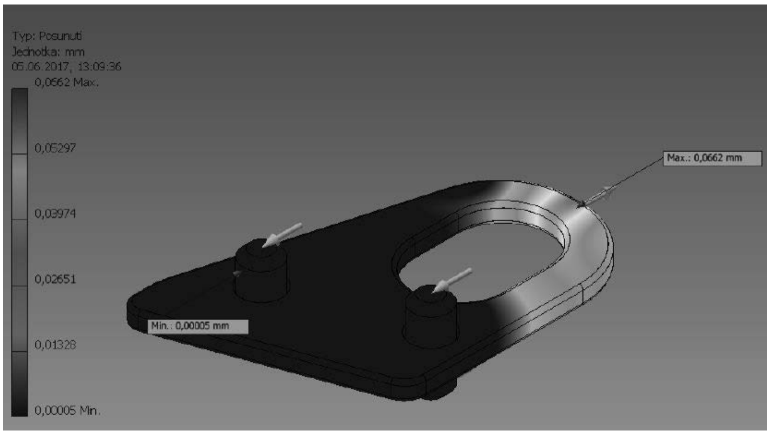

Fig. 5 The calculation of the overall displacement in program Autodesk Inventor Profesional

CONCLUSIONS

According to the input parameters was achieved by matching the design solution. In the design of optimized solutions part of the automatic setting mechanism of optimizing the suspension of the eye. The subject of optimization was the material for better mechanical properties, in addition has occurred in the formation to optimize the thickness of the material used, and from a value of 30 mm for the final 25 mm which contributed to the saving of weight and total production costs of the mechanism. Another subject of the optimization was the modification of the peripheral edges part of the mesh from bevel edges on edges the rounded and it from the outside and from the inside of the eye. The rounded edges allow you to reduce risk of increased concentration of tension in the edges area and this leads to prevention of the occurrence of permanent deformation of the component. In addition, we achieved improvements in the field of surface treatment of pins and in particular the precision of the production, which was especially needed due to a reduction in skin friction occurs when you move the mesh in the frame of crane forks in search of the right position of the centre of gravity.

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