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OPTIMIZATION OF THE PRESS FRAME LKDS 800

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Abstract: *This paper deals with the elasticity analysis of the design of the frame of the LKDS 800 blanking crank press. Mentioned thereinafter is a description of the optimization procedure executed by the Technical Calculation Department in cooperation with the Designing department. The aim of designing of the press frame (and also of the whole press) is the most effective design of the structure.*

Keywords: ***Elasticity analysis, blank crank press.***

1. Introduction

The paper includes the description of the optimization procedure of the frame of the LKDS 800 blanking crank press based on the elasticity and strength analysis (this analysis is performed at Žďas for all designs of new structures and equipment in cooperation between the Technical Calculation Department and Forming Machines Designing Department).

The model of the press is created by the Designing Department using software Unigraphics NX3, then exported to the computing software MSC-Mentat, where the model will be created for the computing system or the solver Marc. From the results we obtain the deformation and stress state of the given frame of the press; these values are used for elasticity and strength evaluation. In case of elasticity evaluation, the design is being changed until the calculated deformations conform to those required.

If the elasticity analysis is finished, then the execution of the strength analysis (it is not presented herein) can be started using software SKALA. The design is changed again to conform to the limit states of sadden fracture, ductile fracture and fatigue fracture and crack propagation.

2. Model description

The LKDS 800 blanking double point crank press (see Fig. 1) is intended for production of blanks for the transfer press, version 4000.

As this is an extensive task for which there is no place in this paper, so only one component of the press structure has been chosen for analysis. In this paper, the frame is the subject to be analyzed. The aim is to make the most effective design of the press frame (even the whole press) to meet the required values of side and longitudinal rigidity and also strength.

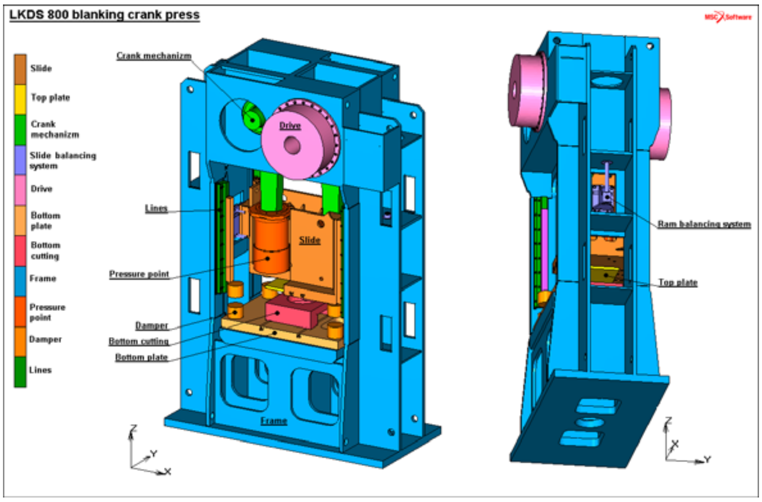

Fig. 1: LKDS 800.

For correct determination of the frame rigidity and strength, the design model of the press must consist of the following: frame, slide, slide balancing system, crank mechanism, pressure point, holder (holder

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load), blanking stroke dampers and drive. The correct arrangement of these components will have an influence on the flow of forces in the whole equipment. The components have an essential effect on the press and frame rigidity.

3. Elasticity calculation

The computing system MSC.Marc 2008 – elastic field has been applied with the utilization of spatial elements. The optimization is performed using direct method (calculation repetition).

The whole press assembly is solved taking into account a contact between the individual parts of the welded structure, which are in interaction – Z1 load. Design model, load and boundary conditions are illustrated in Fig. 2.

The operating load spectrum is not specified by the structure, so the above mentioned stationary load (Fig. 2) is only taken into account. The press performs cutting with a frequency of 28 cuts/min. It is, therefore, necessary to consider the permanent life of all critical parts.

To get satisfactory results from the task, the following preconditions for the design have to be met: The load is considered to be static. It is a linear calculation (permanent force of Hooke´s law). Geometrical non-linearities have been applied (contact task). The dead weight of equipment is taken into account in the calculation.

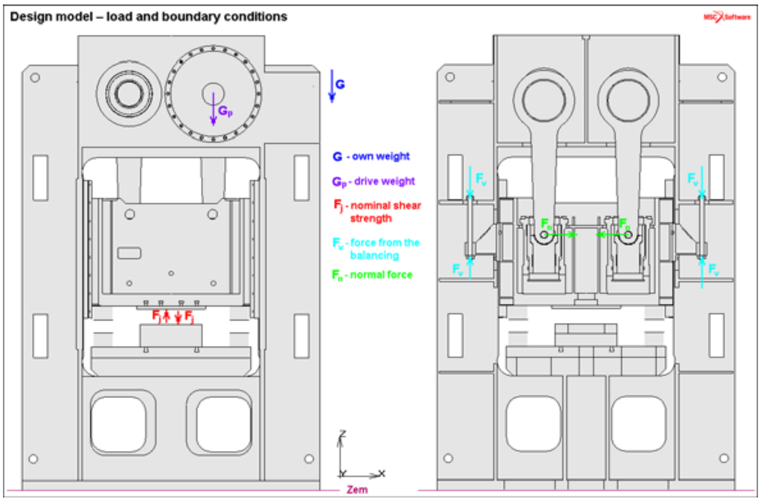

Fig. 2: Design model – load and boundary conditions.

4. Elasticity calculation results

The frame is checked that the deformations in the direction of the global Z-axis of the bearing hub and frame plate do not exceed the limit values of deformation. The bearing hub was designed in three versions – see Figs. 3 - 5. After the calculations are finished, the calculation considered to be the best variant has been chosen by comparison of deformations and production labour consumption.

The frame plate was designed so that it conforms immediately to the required deformation value (higher deformation would be undesirable), see Fig. 6.

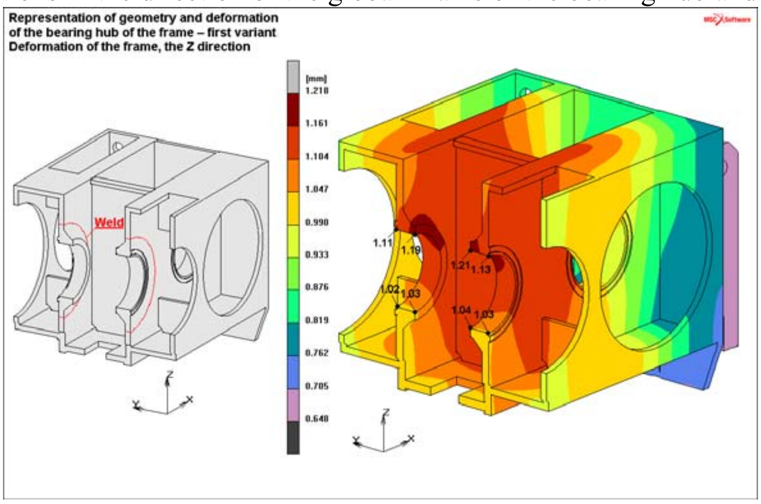

Fig. 3: Geometry and deformation of the first variant.

The stress is checked in the whole structure of the frame and subsequently the critical points are chosen for strength evaluation, Fig. 7.

Graphic outputs of individual variants of the bearing hub and bolster plate (deformation in the direction of the global Z-axis, main stress σ_1, design (reduced) stress σ_{HMH} (acc. to HMH) - all values in mm, MPa]), see Figs. 3 - 7.

The first variant (Fig. 3) is most intricate as regards the shape of the bearing hub design. This hub is inserted in the wall panel and then through-welded using the weld K.

The second variant (Fig. 4) is not intricate in light of manufacture. The rim hub is placed on the panel of the wall and welded all round from the inside and outside using the weld 1/2 V; for this design variant, the weld is not through-welded.

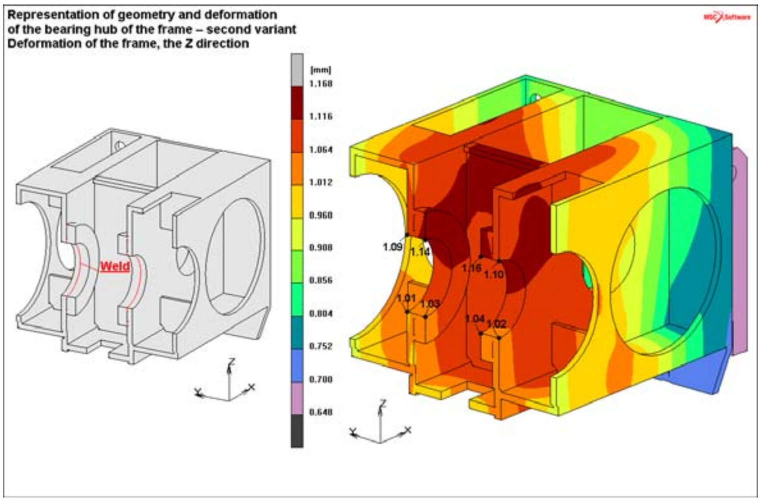

Fig. 4: Geometry and deformation of the second variant.

The third variant (Fig. 5) is not also intricate as regards the production. The tubular hub is inserted into the plate and then through-welded using K-weld.

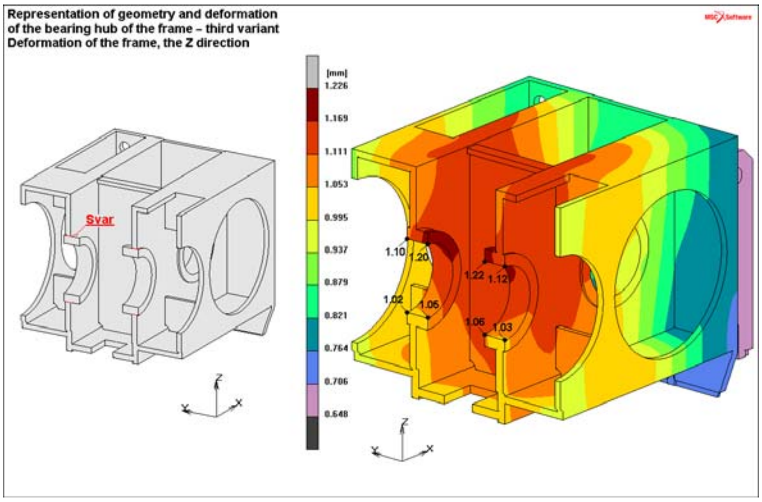

Fig. 5: Geometry and deformation of the third variant.

The design of the frame plate can be seen in Fig. 6. Frame plate rigidity is influenced by holes for removal of blanks and waste.

By the difference in deformations of the bearing hub at the front and rear parts we will get a review of possible displacement of the crank mechanism (Tab. 1). From the designers´ experience, the difference should not reach the value 0.1 mm, so it results in the avoidance of edge contact between the slide bearing and the eccentric shaft. If the difference reaches the above value, it is necessary to optimize the design.

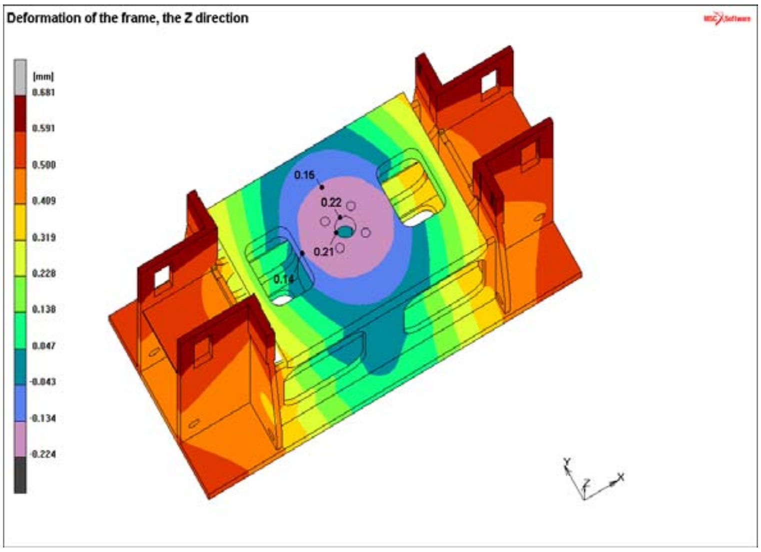

Fig. 6: Frame plate deformation.

Tab. 1: Bearing hub deformation.

Bearing hub	***part 1 [mm]***		***Deformation difference***	***part 2 [mm]***		***Deformation difference***
	front	***rear***		***front***	***rear***	
First var.	***1.11***	***1.19***	***0.08***	***1.21***	***1.13***	***0.08***
Second v.	***1.09***	***1.14***	***0.05***	***1.16***	***1.10***	***0.06***
Third var.	***1.10***	***1.20***	***0.10***	***1.22***	***1.12***	***0.10***
The limit value is 0.10 mm						

Tab. 1 shows that the third variant is not satisfactory. So we can choose only the first variant or the second variant. The designers have chosen the first one.

By the difference in deformation of the frame plate on the inside and outside we will obtain the plate deflection value that cannot exceed 0.1 mm (derived again based on the experience. Then it is also necessary to optimize the frame.

Tab. 2: Frame plate deformation.

Table plate	***part 1 [mm]***		***Deformation difference***	***part 2 [mm]***		***Deformation difference***
	inside	***outside***		***inside***	***outside***	
First var.	***-0.21***	***-0.14***	***0.07***	***-0.22***	***-0.15***	***0.07***
The limit value is 0.10 mm						

For this node of the frame, we succeeded in achieving satisfactory results just after performing the first calculation. It was not, therefore, necessary to make further design changes and calculations accordingly.

The above Fig. 7 - principal and reduced stress - shows that in the structure there is no local increase of tension values (this has been tested by the subsequent strength evaluation which is not, however, presented herein in view of the extensive task).

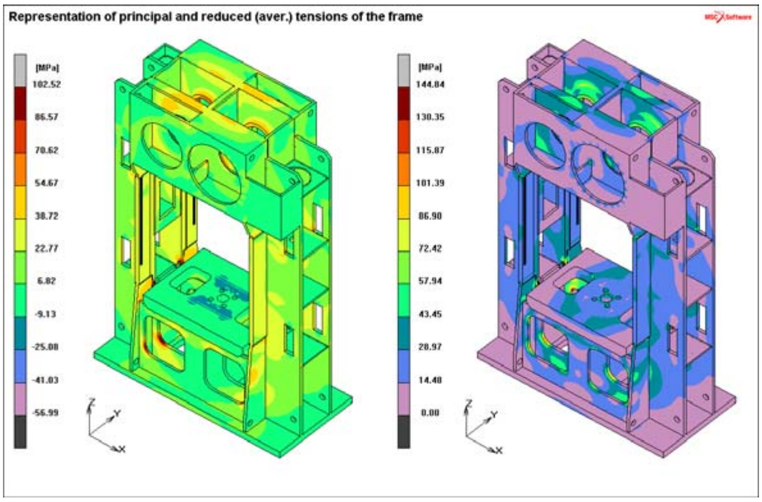

Fig. 7: Principal and reduced tensions of the frame.

5. Conclusion

This paper includes the description of the optimization procedure carried out in designing of new structures at ŽĎAS, a.s. The model has been created using the computing system MSC. Mentat and it serves for sequential designing of equipment and its nodes. This procedure enables the designer to check the elasticity and strength possibilities of the structure. Based on the results he decides how to modify the structure next. At present (when this paper is being drawn up) the whole structure is still in the phase of development, but there will not be made any changes in the shape of the chosen bearing and table parts.

References

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