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COMPARING EXPERIMENTAL MEASUREMENT AT MACHINE AND OF ITS MODEL WITH SIMULATION IN CAD

POROVNÁNÍ EXPERIMENTÁLNÍHO MĚŘENÍ NA STROJI A JEHO MODELU SE SIMULACÍ V CAD

Abstract

There are some dangerous places (entry pin to the crossbeam, place with steam dome joint, etc.), as shown by experimental measuring of the crossbeam. FEM must be used for virtual simulation using the acquired data. The purpose of calculation by FEM is endeavor to advance and optimize the construction unit in the construction of a curing press. An important step in verification and comparison of new construction designs by FEM is experimental measuring and checking. It is possible to perform experimental checks on a modification of a real machine or on a model of a real mechanism. It is convenient to make a model, everything can be edited easily on a loadless running machine. After checking it is possible to enter results into FEM and create data for further engineering designs.

Abstrakt

Z experimentálního měření horní traverzy vulkanizačního lisu 100“ v provozu vyplývá několik nebezpečných míst (vstupu čepu do traverzy, místo připojení parní komory apod.) Pro virtuální modelovaní je potřeba zanést tyto zjištěné údaje do řešení pomocí MKP. Cílem výpočtů pomocí MKP je snaha o další vývoj, popř. optimalizování konstrukčních prvků ve stavbě vulkanizačních lisů. Důležitý krok v ověření a porovnání nových návrhů v CAD je experimentální měření a ověřování. Experimentální ověření lze provést na upraveném reálném stroji nebo vyrobeném modelu skutečného zařízení. Výhodnější je tvorba modelu, kde je možnost vše snadno upravovat bez zatížení provozu stroje. Po ověření lze výsledky zpětně zadat do MKP a vytvořit tak podklady pro další konstrukční návrhy.

1 INTRODUCTION

Curing presses are used to produce tyres, to form and vulcanize a semi-product into a tyre. The basic function of every curing press is to secure opening and closing of the press, and eduction of the closing force and to hold the pre-stress for the duration of vulcanization. This design concept results from this, which strongly influences the weight, size (covered area), reliability, safety and machine maintenance.Proportions of tyres are limited by the inside diameter of the steam dome (or size of heating plate), height of forms and proportion of tyre beading. In construction of big curing presses (presses for production of tyres for lorries) a mechanical-hydraulic type of press is most often used where the closing force is made and kept by the crank mechanism, rod, frame and crossbeam of the press (see fig. 1).

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2 CROSSBEAM OF THE CURING PRESS AND ITS LOADING

From measurements of the curing press in operation, several dangerous places emerge. Particularly the place where the pin enters the crossbeam – half of the closing force is transferred over both pins. The second dangerous place is the place where the steam dome joins to the crossbeam. In this place the crossbeam is loaded by the whole closing force.

Fig. 1 Crossbeam of VL 100”

2.1 Tensiometric measurement

With the help of a wire (foil) tensiometer stuck on the parts of the machinery to be measured it is possible to determine its straining during running. It is possible to follow the course of cyclic straining of single parts, for example, during one working cycle. From these results it is possible to correctly dimension individual parts, or find, for example, reasons for running strain, faults in the process or the loading mechanism. The results can be used to innovate designs or to improve the construction from an economic point of view. Tensiometric metering also makes possible measurements of dynamic power, deflection, torque on shaft, wheels during one or more speed or cycle of the machinery. Together with monitoring the course of speed, the method allows the instantaneous input of the mechanism to be determined at any moment.

2.2 Analysis of crossbeam VL 100"

FEM was used in an attempt to further develop the construction of a curing press**.** Actual detection of dangerous places on the crossbeam and design changes for their elimination. Calculations were carried out for the crossbeam of the VL 100" (existing design) and are connected to the research report: Cechura, M., Kucerova, M. *Crossbeam of VL 100" press – Tension analysis of the crossbeam of curing press VL 100*", Pilsen 2001.

Boundary conditions of the simulation:

1. The force exerted on the tie bar of the press is 6.25 MN. The force on the pin is defined with help of fictional elements to enable its distribution to be defined as continuous loading (see fig.1). Because of the effects of pressure, the load force is set at 6.5 MN.
2. The load of the cross beam is transferred through a hollow cylinder which substitutes the effect of the mould. The roller is fixed in all directions in the lower part (see fig.1).
3. All welds are assumed to be homogenous and the material values for the whole weldment is the same for the whole assembly, including the welds (the material is 11 523 steel)

The model was created in I-Deas by the cubic element.

Calculation showed, in accordance with the operation conclusions, stress concentration in the following places:

- storage rod on pin of crossbeam (fig. 2-A),
- where the pin enters the crossbeam (fig. 2-B) and
- the interior strut above the interface of the steam dome with the crossbeam (fig. 2-C)

In critical places the strain value reached above critical values for the material used (11 523.1), up to 380 MPa. In these places there is the threat of destruction of the crossbeam. In some places, namely where the pin is between struts, crossbeam tension reaches relatively low levels and here it would be possible to reduce the profile. (fig. 2-D).

lace	Strain [MPa]
	380
	375
	360

Tab 1 Table of tension in critical places.

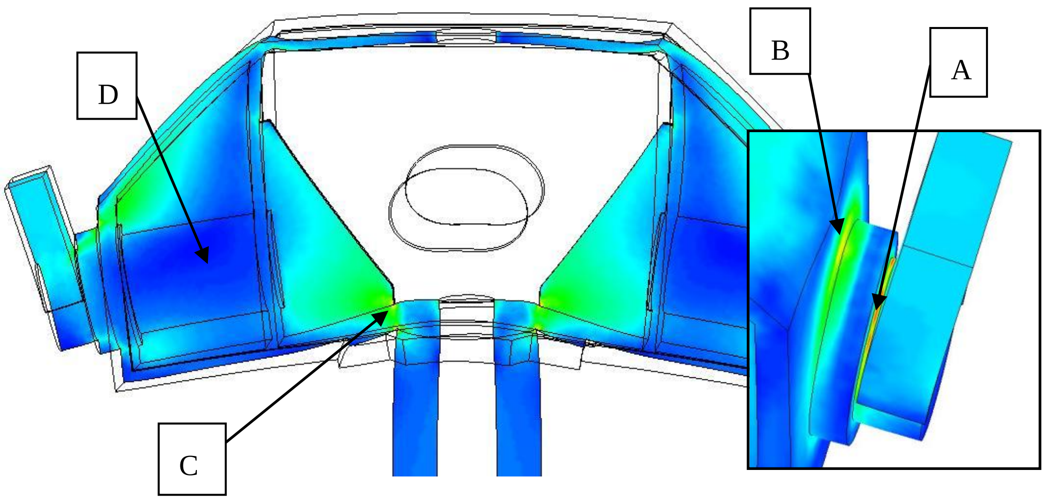

Fig. 2 Calculation of crossbeam with essential points for pin adjustment.

2.3 Experimental checking of the CAD simulation on a model

To optimize variants, which cannot be realized on the actual mechanism, experimental measuring was realized under laboratory conditions on a reduced scale model crossbeam of a curing press. This model was created from Plexiglas, a material widely used in production and testing models. Model (see fig. 3) was created at a scale 1:5 in a range of variants. The variants allowed changes to the thickness of single components and following the behaviour of the model crossbeam in relation to strain in selected places and its total deflection.

Loading was carried out by caliber weights and hydraulic jack and the course of the strain in critical places was checked by the attached tensiometers and general deflection was monitored by micrometrical contact. Results were subsequently converted by means of a coefficient (characteristic of the Plexiglas and characteristic of the steel).

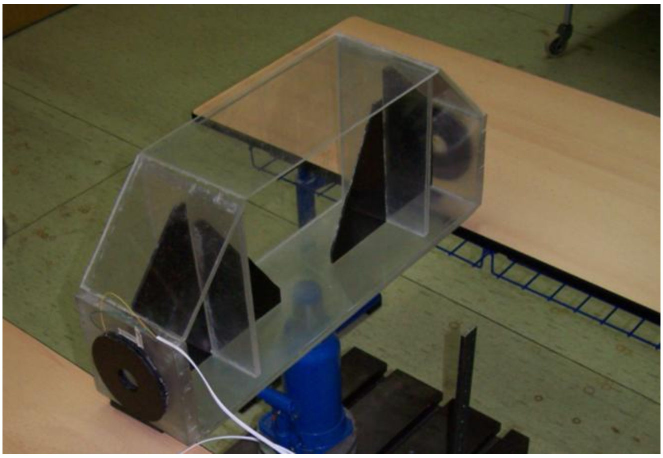

Fig. 3 General view of the model crossbeam with tensiometer.

3 CONCLUSIONS

Numerical simulation with the help of FEM showed stress concentration in the same places as experimental metering (see fig. 2 - A, B, C) - storage rod on pin of crossbeam, place of entry of pin to the crossbeam and inside struts above the interface of steam dome with crossbeam. In these critical places strain was found above the strength limit of the material used (11 523.1), up to 380 MPa. It was verified that destruction of crossbeam may occur.

Virtual constructional adjustment of the crossbeam managed to eliminate stress concentration to an acceptable value from 380MPa to 257MPa. The strain dropped below limits of yield strength and there is no threat of permanent deformation. General constructional adjustment resulted in lowering the mass of the crossbeam by about 0.8 tons.

The results of the analysis with the help of FEM calculation and virtual prototyping were checked on a Plexiglas model. Plexiglas is, for this kind of experimental model, the best suitable material in view of its material quality and it has similar characteristics to a steel model. The model, from the perspective of optimization, was specified as variant group (with the possibility of moving and exchanging components of different thickness), which was problematic in measuring strain and deflection and the results were not unambiguously verified.

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