58th ICMD 2017
6 - 8 September 2017, Prague, Czech Republic

TESTING MEASUREMENT DURING THE SHAFT ASSEMBLY OF THE OILSEED SCREW PRESS

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Abstract
The application of strain gauges experiment was used for analysis of a production inaccuracy during the assembly. The components (inserts and screws) were placed on the shaft and the deformation on specified places was measured so the influence of the geometrical accuracy was observed.

Key words: *experimental measurement; strain gauges; geometrical accuracy.*

INTRODUCTION

Oils are important components of different plants, nevertheless oilseed such as soyabean, rapeseed, sunflower, cottonseed and others are mainly utilized in commercial oil production. There are different oil extraction processes consisting of specific operations, oil pressing is one of them. The mechanical pressing with expeller utilize a rotating screw inside a horizontal cylinder that is capped at one end. The screw forces the seeds through the cylinder with gradually increasing pressure, reported by *www.attra.ncat.org*.
Measurements and experimental testing on machines are very important and are used firstly to obtain the information and parameters of the real components or processes. The measured data can be further utilized for the subsequent optimization of the specific parts, structural units or set up of the operational parameters. The measurements are also used for validation of computational simulations and analysis (*Berka et al. 2015, Dub et al. 2014*).
This article focuses on the experimental measurement on the shaft of the oil press using strain gauges to find out the dependence between the production accuracy of the parts geometry and the deformation of the shaft during the assembly.

MATERIALS AND METHODS

Investigated machine. The described measurement was carried out on the shaft of the oilseed screw press (figure 1) during the assembly in the premises of the producer. The final assembly of the shaft that is placed in the oilseed screw includes also the inserts and screws firmly fasten on the shaft by a special nut.

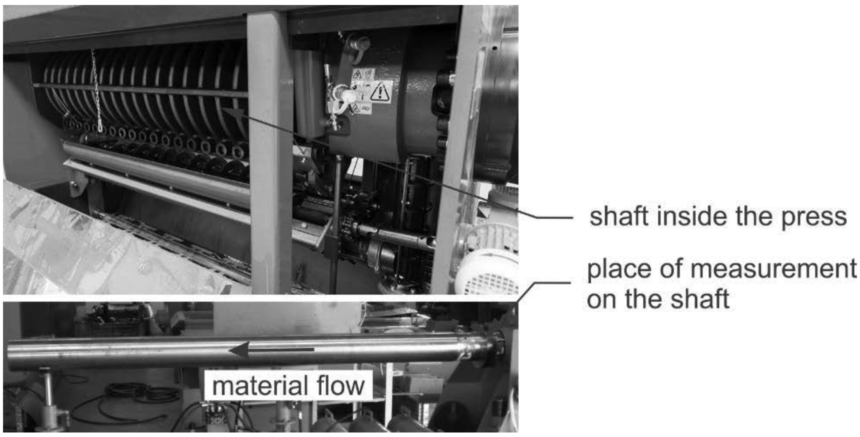

Fig. 1 Oilseed screw press FS 1010 and the measured shaft during the assembly, *www.farmet.cz*

Instrumentation and measurement protocol. The detailed scheme of the tested shaft with the measurement points can be seen in figure 2. Three strain gauges were placed in a groove at the end of the shaft. Regarding the flow of the material through the oil press, the measuring place was in the input end of the shaft. The strain gauges were used to obtain the uniaxial stress in three places in positions by 90° (see detail A and the cross-section B-B of the scheme in figure 2)

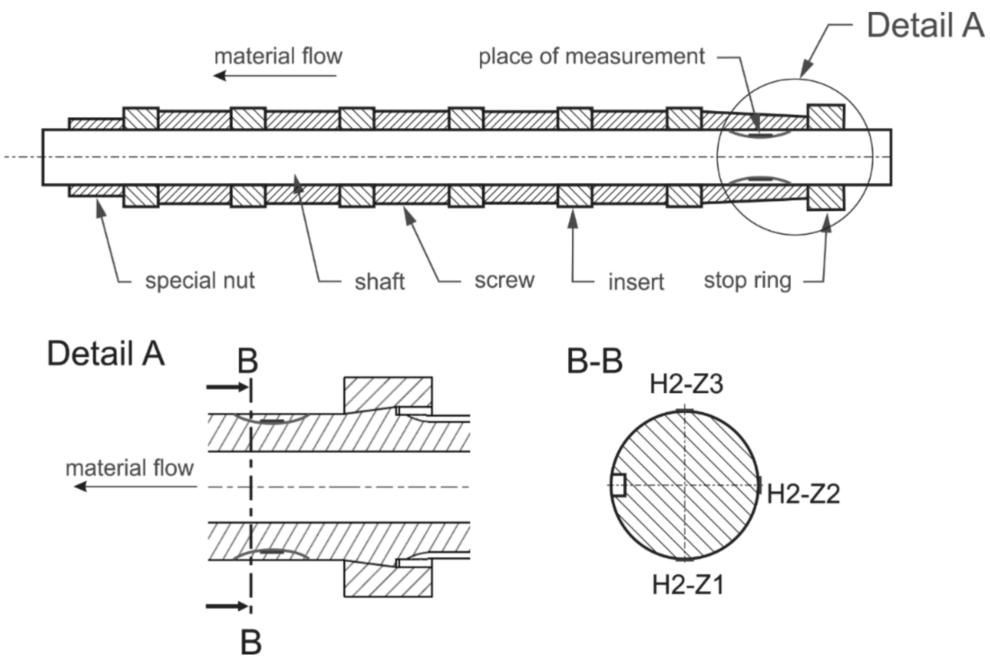

Fig. 2 Scheme of the tested shaft and detailed place of measurement with strain gauges

The set of three T rosette strain gauges with two measured grids HBM 1-XY11-6/120 in half-bridge configuration for axial strain measurement were used, *www.hbm.cz.*
The assembly of the shaft comprises of the insertion of the hubs (screws, spacers, inserts) on the shaft followed with the tightening by a special nut in precisely specified steps of the tightening moment (65 Nm, 130 Nm, 195 Nm, 250 Nm). The whole measuring cycle included also the loosening of the nut with the specified steps.

Data acquisition and processing. The National Instruments apparatus (Wi-Fi chassis cDAQ-9191, strain gauge measuring module NI-9237) and software LabView were used for the strain gauge measurement with the sampling frequency of 1000 Hz, see also *www.ni.com*. The data processing was performed in LabView software. Data were processed by Matlab and LabView software. The example of obtained time dependent filtered data from strain gauges in graphical form transformed to the uniaxial stress for the tightening is shown in figure 3.

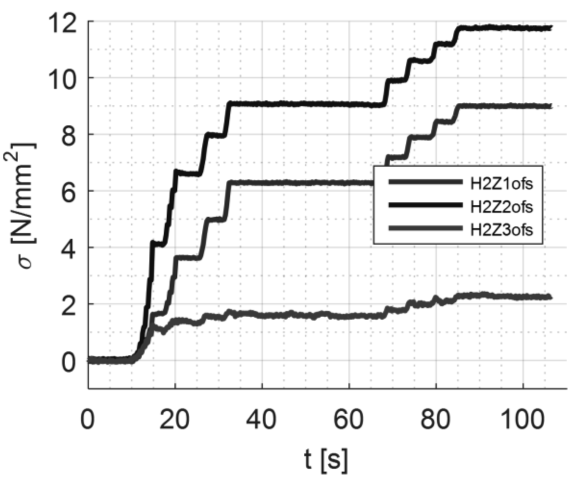

Fig. 3 Example of the measured data from the strain gauges

Experiment outcomes. The resultant stress components in the shaft were calculated from the stresses measured by the strain gauges. According the scheme in figure 4 the chosen stress components are tensile stress, bending stresses in the horizontal and vertical planes. The equations (1) are used for their determination from the measured data.

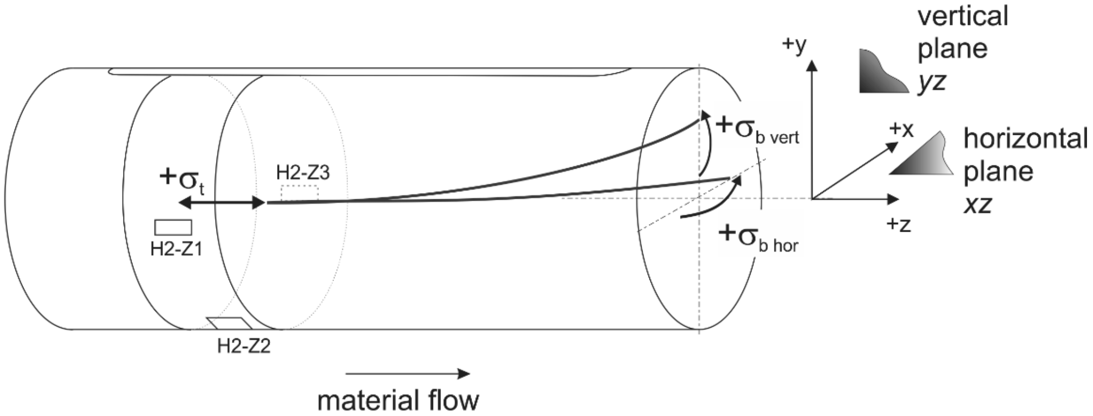

Fig. 4 Scheme of stress components in the shaft

$$\sigma_t = \frac{\sigma_{H2-Z1} + \sigma_{H2-Z3}}{2} \qquad \sigma_{b\,hor} = \frac{\sigma_{H2-Z1} - \sigma_{H2-Z3}}{2} \qquad \sigma_{b\,vert} = \sigma_{H2-Z2} - \sigma_t \qquad (1)$$

RESULTS AND DISCUSSION

Based on the measured data and determined stress components with help of equations (1) the final time dependent course of the stress components in the shaft is shown in figure 5 where the whole cycle comprising from tightening and loosening of the special nut is obvious.

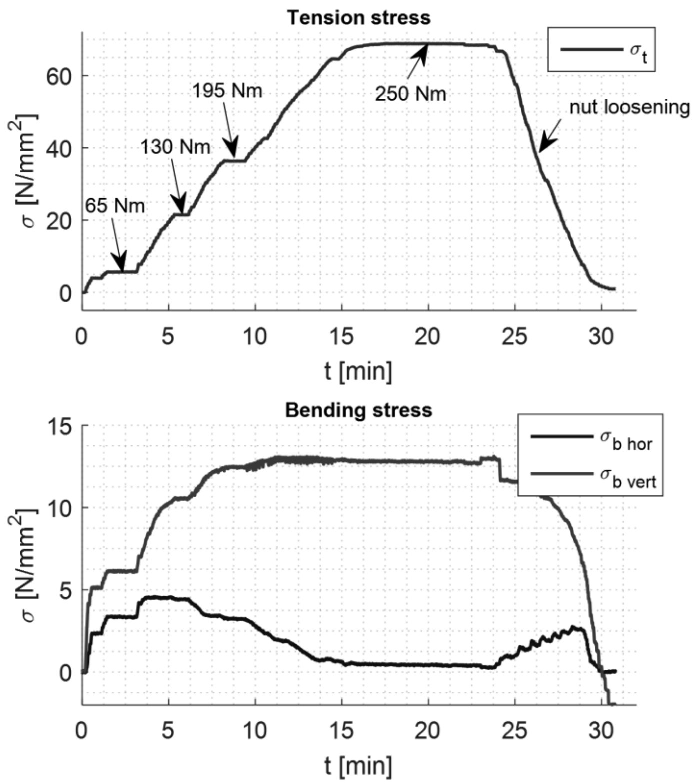

Fig. 5 Stress components dependent during the measuring cycle

The measured and processed data, i.e. the stress components in the shaft, were further analysed in comparison with the measured geometrical accuracy of the components (screws and inserts). The points of measurement in two planes on the components with the example of the accuracy analysis are shown in figure 6. The measured deviation in the points corresponds to the axis z, so the parallelism of the plane 1 and 2 can be determined.

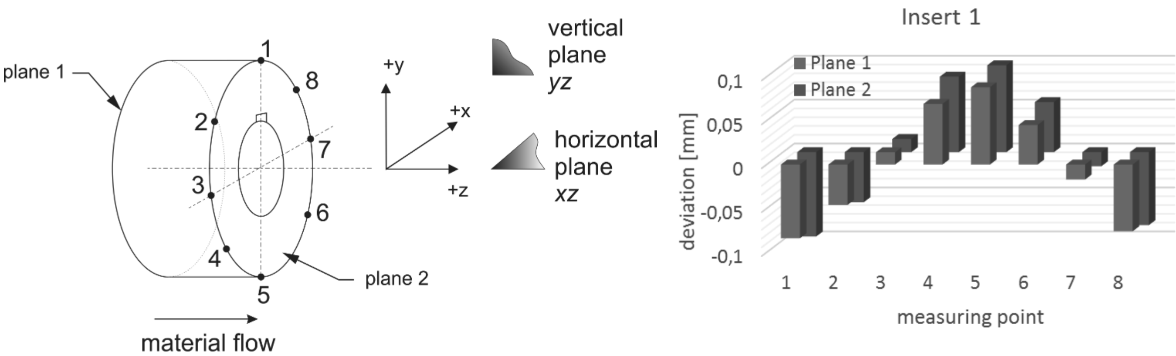

Fig. 6 Geometrical accuracy analysis of the components

The measured deviations in points1 and 5 fit the bending stress in the vertical plane, in points 3 and 7 fit the bending stress in the horizontal plane. The production inaccuracy of the first screw near the measured place has the significant influence on the bending stress in corresponding planes. The decrease of the bending stress in horizontal plane when the nut is fully tighten can be explained by the backlash elimination between the components.

CONCLUSIONS

The text describes the experimental method and its application where the strain gauge measurement and geometrical analysis are combined. First of all, the influence of the components production accuracy on the stress intensity of components in the real applications can be determined by this method. In the specific case the influence of the production accuracy on the stress distribution is evident.

ACKNOWLEDGMENT

This research has been realized using the support of Technological Agency, Czech Republic, project TA04010992, Research and development of technologies for obtaining vegetable oils and oil-cakes with an emphasis on quality of oil-cakes as feed and the appropriateness of used of the construction materials.. This support is gratefully acknowledged.

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