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STRAIN FIELD MEASUREMENT ON CYLINDER LINERS OF ENGINE BY HOLOGRAPHIC INTERFEROMETRY.

MERANIE DEFORMÁCIE VLOŽIEK VALCOV MOTORA POMOCOU HOLOGRAFICKEJ INTERFEROMETRIE.

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V článku je popísané meranie deformácie vložiek valcov motora traktora Zetor UR-IV metódou HI. Boli zistené deformácie na vnútorných plochách vložiek valcov vznikajúce pri kompletácii motora v dôsledku nepresnosti vŕtania valcov. Vyhodnotenie bolo uskutočnené kruhovou metódou a výsledky boli znázornené v 3-D zobrazení.

Keywords: strain, holographic interferometry, engine

Interferogram processing by the circle method has been used to evaluate possible causes of a failure in cylinder liners of a tractor engine. There is presented the strain evaluation on the unfolded inside surface of cylinder liners as three-dimensional representations. All this has been elaborated at The Department of Physics at The University of Agriculture in Nitra.

Probably owing to technological process by cylinder boring machine a piston rub occurs in the border cylinders of an engine of a heavy-duty Zetor tractor [1]. To verify above mentioned hypothesis the strain measurements of the border cylinder liners related to central cylinder liner were carried out. The measurement method consist of the obtaining of double exposure hologram [2] before and after assembly of a cylinder block with a cylinder head, the evaluation of the holographic interferograms by a more precise processing of a fringe counting method proposed in [3], and the computer processing of the results for the appropriate comparison of the border and central cylinder liners.

Holographic interferometry permits the determination of the three components of displacements at a point on the surface of a stressed object. If the double exposure technique is used to generate the interference fringe pattern which results from a displacement change, the sign of the displacement cannot be unabiguously determined from the pattern [4]. The sign of the strain can be deduced from an auxiliary experiment, where the conditions are known. In the work described in this paper, moving of an auxiliary element of an experimental setup was used as a comparative method in order to check signs of strain values derived from holographic interferograms.

The typical laboratory configuration using the beam splitter [5] was not applied because it was necessary to illuminate and record the whole inside surface of a cylinder liner simultaneously. In our case, the configuration of fig.2 was proposed and used with red-light laser (He-Ne, LA 1001, 0.11W) of 40cm coherence length which permits to represent the whole inside cylinder surface.

To evaluate the holographic interferograms there was used the circle method, which is based upon FC-method described by equation [4]

$$dN\lambda = -\vec{dn}.\vec{\Delta r} \qquad (1)$$

where dN - change of an interference order, λ - wave length, $\vec{dn}$ - change of an observing direction, $\vec{\Delta r}$ - displacement vector.

If we realize measurements by several changes of observing direction $\vec{dn}$ to which is applied the minimalize of the errors by the least square method, we can derive this equation

$$|\vec{\Delta r}| = \frac{\Sigma x_i^2 + \Sigma y_i^2}{\Sigma x_i} \qquad (2)$$

where x_i, y_i, are reduced components $\vec{dn_i}$.
Eqs.(2) represents circle method (in detail see [3]).

The results of the computations done by the circle method are shown in figs.4-6 as 3-D representations. Errors of the results due to inaccurate input values, can be derived by the statistical method. This is the way by means of which we were able to determine the extreme error as 1.5 m.

This paper presents a laboratory method that uses holographic interferometry to determine the magnitude and sign of strain at points in the inside surface of the engine cylinder liners.

As it is shown in figs.4-6, border cylinder liners are more strained than a central cylinder liner. These deformations are caused probably by inaccurate boring of border engine cylinder, which are emerged after assembly of an engine.

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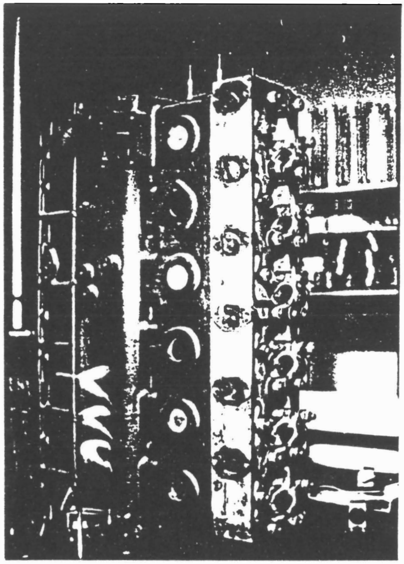

Fig.1 Cylinder block with an adapt cylinder head that enable to record hologram.

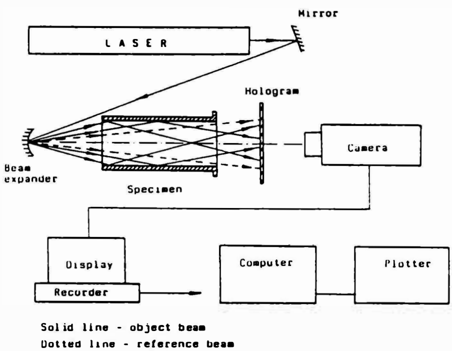

Fig.2 Experimental arrangement.

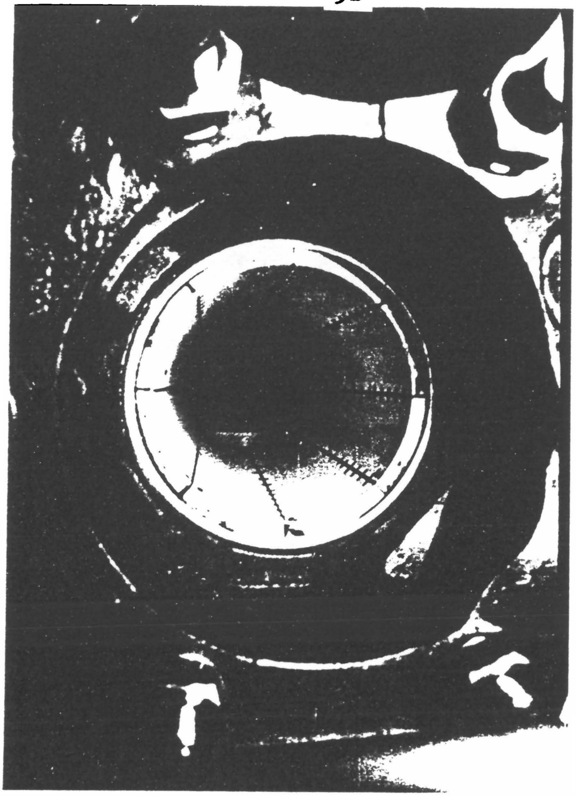

Fig.3 Look at the cylinder liner inside surface through an adapt cylinder head.

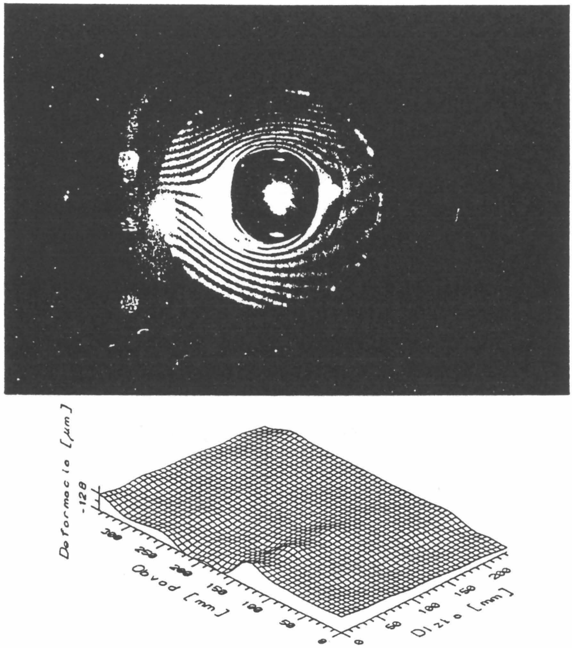

Fig.5 Holographic interferogram and the unfolded inside surface of the cylinder liner illustrating strain of the central cylinder after mounting of a cylinder head.

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