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ISOCHROMATIC ANALYSIS OF THE GROOVE AXES FOR FRAME DRAFTING

PAUNESCU, D[aniela]; HANCU, L[iana]; SUCIU, M[ihaela] & PAUNESCU, M[ihai] - V[alentin]

Abstract: *Two groove models have been tested through the fotoelastic method, the first model from the real situation, the second model with the optimization profile. The optimization groove's profile has been generated before, through finite element analysis.*
Key words: *stresses, strains, isochromatic, finite element analysis*

1. INTRODUCTION

The stresses and the strains that appear at the groove spindles can be visualized and checked through the fotoelastic method. Fotoelasticimetria is build up on the property of accidental birefringence of some transparent materials that are named optic active. These materials, in unstressed stage, are isotropic from the optical standpoint but they become birefringent then when they are put to mechanical strains. A polarized ray of light that traverses such an active optical material discomposes in two parallel vibrations with the directions of the principal stress. A network of interference with different intensities in lights and shadows is set up when a monochromatic source of light is used or in the colours of the spectrum when the white light is used. The position of the network of interference is directed after the direction of the stress and their measure is determined on the value of the tensions. The image that is formed after traversing the tested model can be projected on a screen or captured with a digital camera and processed on a computer.

The locus of all the points with equal light intensity, in monochromatic light, or in white light, named izocromata, represent the points of equal difference of the stresses (Păstrăv 2001)

2. ANALYSIS

The geometric model follows the characteristics of a groove spindle (fig.1) .For obtaining the model with finite elements (Hârdău, 1995) the modelling stages have been respected and the analysis present in the ALGOR documentation.

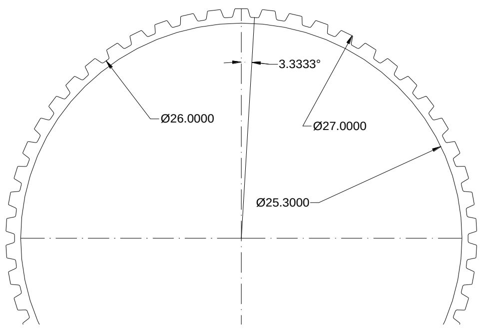

Fig. 1. Geometrical model of the groove roller

The frontier of the analysis domain has been utilized for the generation of a plane domain corresponding to the front plane of the groove spindle. Using afterwards the copy command with the joining of nodes a 3D domain with the width of 1 mm has been generated. Finite elements have been of parallelepipede type.

On the top of the tooth in the corresponding portion of the radius from the top of the groove a pressure with a conventional value has been imposed.

The small dimension of the radius from the top of the groove tooth was the main obstacle in building a full model (fig.2).In these conditions a smaller portion of the groove roller has been chosen.

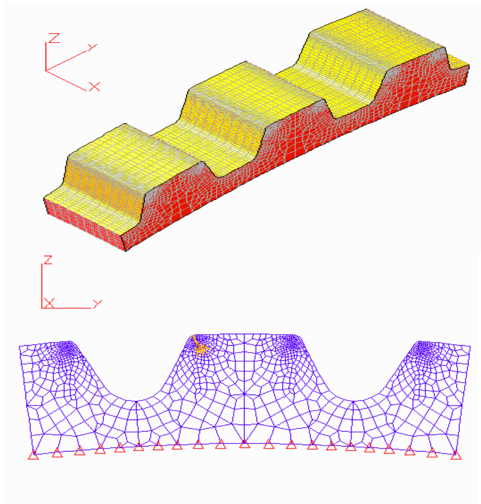

Fig. 2. Model. with 3 teeth and 2 cavities

In the variability conditions considered for the radius from the foot of the tooth (Păunescu & Hancu, 2007) and the profile angle of the groove flank several calculations concerning thstress and deformations have been realized (tab.1).

	Beta=15	Beta =22	Beta= max
R=0.1	c11	c12	c13
R=0.2	c21	c22	c23
R=0.24	c31	c32	c33

Tab. 1. The codes of the analized models

Maximum relative stresses	Beta=15	Beta =22	Beta= max
R=0.1	0.904739	0.95525	0.906658
R=0.2	0.904739	0.953531	1
R=0.24	0.954585	0.925779	0.940732

Tab. 2. Maximum relative stresses

Relative strains	Beta=15	Beta =22	Beta= max
R=0.1	1	0.893081	0.745181
R=0.2	0.993124	0.889586	0.807516
R=0.24	0.990308	0.888847	0.844727

Tab. 3. Relative strains

The stresses obtained in reported values at the maximum obtained values are gathered in Tab. 2 and the reported maximum deformations at obtained maximum for the 9 cases are in tab. 3.

From the point of view of the importance of the influence on yarn'draft in the frame the deformations of the teeth of the groove roller are on the first place (Paunescu et al.2006) We can see from the table nr.3 that the classic R 0.1 and beta=15^{o} construction situation is the worst of them all. The tooth can deform the most because of the sharpened flank and because of the base characterized through a small connection radius.

A study on the profile on the tooth is imposed for finding a profile with minimum influences on the yarn's quality.

3. EXPERIMENT

The model's stress analysis was made through the fotoelastic method using a polariscope, at room temperature.

To verify the measure in which the change of the grooves profile has influenced the state of stress on the edge of the tooth, an experimental model has been realised – a witness model, made of a transparent and optic active material with a thickness of 10 mm (Păunescu & Hancu, 2007). This model is made up for a piece with a groove of a 50/1 profile covered by an elastic top roller in the deformed stage. For similitude, between the two pieces a model of yarns with an equivalent thickness has been set. The ensemble was tested with three different bodies corresponding to real life streams applied to the top cylinders through the pressure arm. The study came to an end with the evaluation of the effect of the changed parameters on the stress from the edge of the groove. For this purpose a groove model with optimised profile has been tested – the new model. The components are the same as in the case of the witness model and the testing was made under the same conditions.

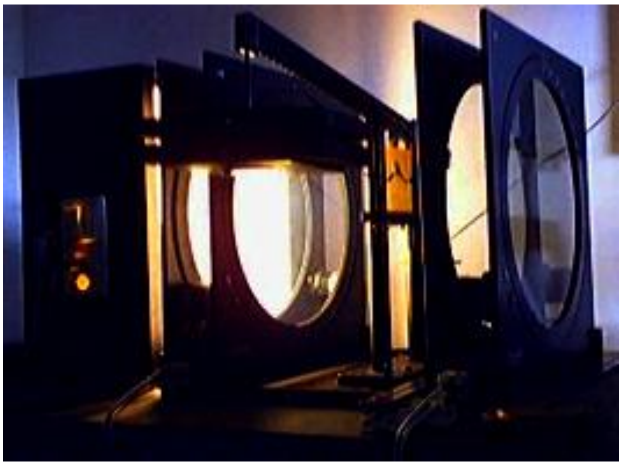

Fig. 3. Polariscop testing the new model

Three tests have been made for each model, with three different values for the force: 54.3 N, 74,3 N and 106 N. (Paunescu, at. al., 2003). The images taken with the digital camera are presented in the figures 4 and 5.

The comparative study of the izocromate from the two models confirms the results from the experimental research with finite elements.

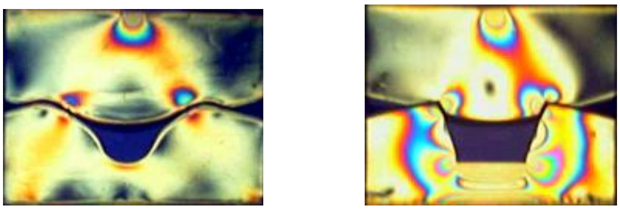

Fig. 4. Izocromates for real profile and new profile at 54,3 N

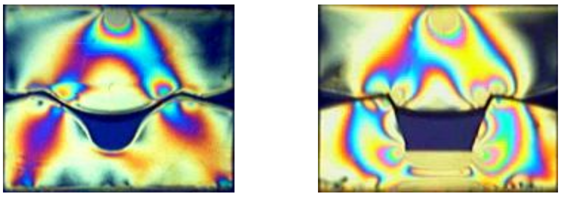

Fig. 5. Izocromates for real profile and new profile at106 N

For comparison, in the bottom of the figure nr.5 the two geometric models are reproduced – c33 corresponding to the new profile c11 to the real profile – with the presentation of the stress situation.

The operation was realised using the compensation method on the two models affected by a force of 106 N, comparable with the conventional loading applied on the geometric models. Knowing the fotoelastic constants of the studied models, determined by the etalon disks the value of the main stress on the edge of the tooth was calculated. (Tab.4)

	σ_o	k	$s_2 = k.\sigma_0$
test model	0,475 N/mm^2	3,6	1,71 N/mm^2
witness model	0,95 N/mm^2	4,2	3,99 N/mm^2

Tab. 4. Principal stresses

The results of the testing on the experimental model using the fotoelastic method confirms the conclusion of the study with finite elements on the geometric model regarding the need of changing the teeth profile from the groove roller at the parameters mentioned in this study.

4. CONCLUSIONS

This case study offers a response to the configuration of the tooth and the free space from the groove cylinder. The existence of a variability regarding the stresses and the strains that appear in the tooth is strong enough to confirm the hypothesis that war made regarding the existence of an influence from the groove's profile on the integrity for the fibres. Even if the stresses and strains are extremely small in comparison to the groove roller, on the structure that is being drafting they can have a_very important effect. Because of the loading, the maximum stress apears in the top part.

We can see that clasic constructive method with radius from the base R0,1 and the angle of the flank beta=15 is the worst of them all. The study opens the possibility of researching other profiles of groove rollers. This work has been supported by the Grant PN II CNCSIS IDEI 205(nr.655/2009)

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