THE APPLICATION OF A TRIBOTESTER PROTOTYPE TO SLIDING FRICTION SIMULATIONS AND WEAR COMPUTATIONS BY MEANS OF FEM

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Key words: *Tribotester, FEM, friction simulations.*

1. Introduction

Modeling of friction is one of contemporary research problem within the area of tribological processes. This modeling, particularly in the conditions of plastic strain, so called an invariable (rigid) – plastic system, is to be performed in a laboratory and through theoretical computations. The lack of suitable methods and research tools providing relevant response to particular systems shows the needs of more detailed analyses. These concern e.g. cooperation conditions occurring in sheet-metal forming.

The authors have designed and constructed a laboratory stand based on Amsler's machine to use it for this analysis. The stand makes possible to test sliding friction systems in dry processes and with the use of lubricants. The model of the designed stand is relevant to a pin on disc system which means that a stationary sample or samples are pressed to a moving counter-sample of a disc form.

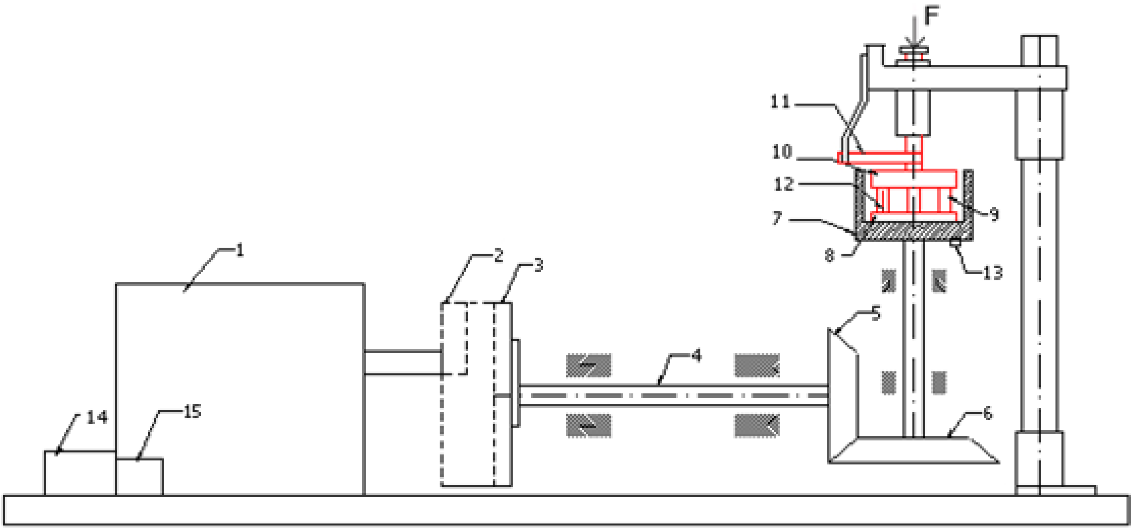
Moreover, a theoretical FEM model has been elaborated to verify the results of physically simulated friction processes in the laboratory. The data that has been worked out refer to the possibility of the use of FEM method to predict the effects of work of particular friction systems. The confirmation of correctness is to be the conformance between the laboratory test results and the FEM computation results. The paper describes the methodology of tests carried out on a modernized Amsler's machine and the modeling problems of assumed friction processes by means of FEM.

The verification of the model construction and computations that has been based on laboratory test results has been also used to establish particular assumptions for model construction and FEM computations.

2. Test methodology

The paper presents an example from laboratory research that has been carried out in the Dept. of Fundamental Technology, Lublin University of technology and refers to friction resistance and wear problems.

The evaluation and analysis of friction wear of products made of C45 materials cooperating with tools of NC6 have been carried out on the described test stand. The weigh method served for the purpose of material wear evaluation. The amount of wear has been tested in time periods. Fig. 1 presents a kinetic diagram of a modernized Amsler's machine where particular mechanical and electronic elements are indicated.



F- pressure force
1. electric engine
2. drive main wheel
3. planetary gear
4. shaft
5, 6. drive cone wheels
7. basket – counter-sample location
8. counter-sample
9. Samples (tested material)
10. measuring head
11. friction moment sensor
12. temperature sensor (thermocouple)
13. rotational velocity sensor
14. control module (start/stop)
15. current meter

Fig. 1. Kinetic diagram of the modernized Amsler's machine

The friction machine type Amsler (Fig. 2.) and its measuring sensors make possible to carry out tests at selected ranges of rotational velocity of the counter-sample and at constant contact load. This enables to apply determined surface pressure between the samples and the disc and to register the moment of friction, rotational velocity and to determine the wear values in time.

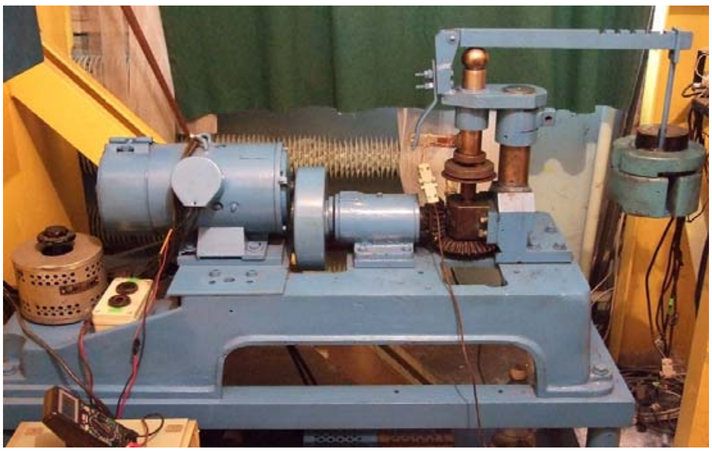


Fig. 2. View on modernized Amsler's machine

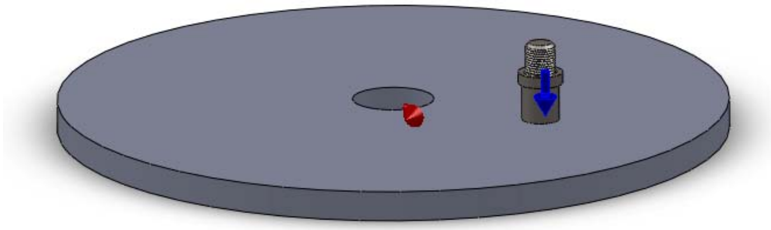


Fig. 4. Model system consisting of a sample and a counter-sample with determined boundary conditions

The constructed model has been subjected to discretization process and then computed by FEM solver. The example of obtained images of strain changes and stresses for tested samples is presented in Fig. 5. Measuring tools form an integral part of the system in SolidWorks and give the response function relevant to volume wear in time.

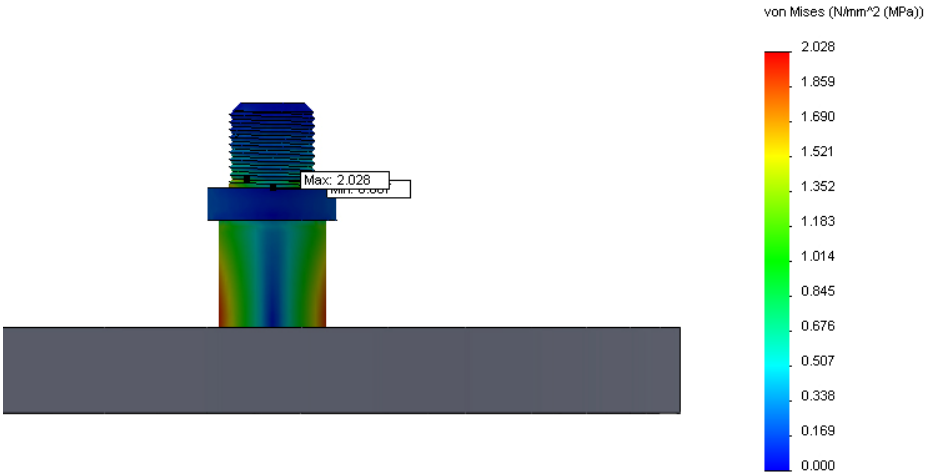


Fig. 5. The distribution of stresses in a sample

3. The analysis and the evaluation of obtained investigation results

As it follows from the selection of obtained computational results (presented in Figs. 6) and from laboratory tests, the simulation of the process is in accordance with the results from real conditions.

Table 1

The selection of sample wear for laboratory tests

Time [min]	Mean sample mass [g]	Counter-sample mass [g]	Mean wear - samples [g]	Wear – counter-samples [g]
0	10,604	386,010	0,000	0,000
15	10,492	385,981	0,112	0,029
30	10,400	385,974	0,092	0,007
60	10,341	385,955	0,059	0,019
90	10,286	385,939	0,055	0,016
150	10,227	385,904	0,059	0,035

On the basis of the obtained effects from the cooperation tests and from computations, the wear values are determined in time function and the graphical presentation is shown in Fig. 6.

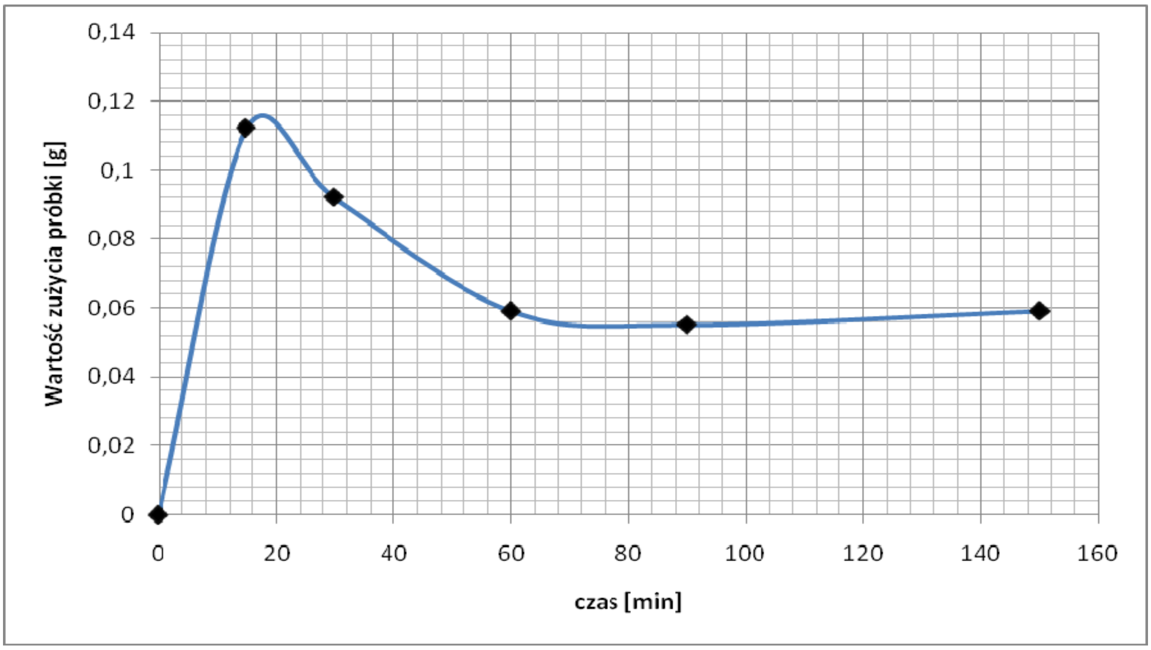


Fig. 6. Time dependent function of sample wear in laboratory tests

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STOCHASTIC AMPLIFICATION OF EXTERNAL IMPACTS

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Abstract: *A property of macroobjects which consists of randomly cooperating microelements with accidental parameters that stochastically amplify external impacts was discovered. It is shown, that under precritical variance of accidental parameters of microelements increments of probability distribution functions of these parameters exceed corresponding increments of initiating external impacts on macroobject.*

Key words: *amplification, probability distribution function, mathematical expectation, dispersion*

I. Introduction

In statistical radio engineering and the nuclear physics [1, 2], in the quantum theory of crystal firm bodies [3], and also in number of scientific areas connected to them [4], while studying the properties of macroobjects consisting of occasionally reacting with occasional features of microelements, probabilistic theory is usually used for determining quantitative reaction measurements on external effects of macroobject as a whole. At the same time issues