THE EFFECT OF EXPERIMENTAL ERRORS FROM HARDNESS TESTS UPON FORCE-DISPLACEMENT RELATIONSHIP

Ştefan Beşliu[1], Traian-Lucian Severin[1], Stelian Alaci[1], Florina Carmen Ciornei[1]

[1] *Faculty of Mechanical Engineering, Mechatronics and Management, "Stefan cel Mare" University of Suceava,[1]alaci@fim.usv.ro.*

Abstract: *The paper considers estimating the effect of indentation and force measuring errors on the contact force-deformation exponent for the elasto-plastic contact. First, the experimental data obtained when pressing ball bearings and a conical punch against the plane surfaces of aluminium and steel cylinders. Because of the polygonal aspect of the hysteretic curves, the experimental data were momentarily overlooked in favour of the experimental data for determining microhardness with dedicated equipment. The experimental data from the loading period were interpolated with a power function. It was found that the value of the exponent of force-displacement dependency is very close to the theoretical value. It was assumed that the values used in estimating the force-displacement were greater than the experimental ones. With the forces and displacements affected by the imposed errors, the value of force-displacement exponent was determined again. The effect of the two errors is very strong. So, if the estimation of force and displacement are obtained with a relative error of 10%, the error for the force-displacement exponent is close to 60%.*

Keywords: *contact hysteretic loop, experimental data fitting, force-displacement exponent*

1. Introduction

The first study in the field of contact mechanics is due to Boussinesq's, [1]. It solves the problem of the stress and strain in an elastic half-space acted on the limit plane by a concentrated force. Shortly after that Hertz, [2], publishes and article in which, observing that the equations that describe the stress and deformation for two elastic objects are similar to those from the electric potential theory, determines the formulas that allow the finding of the maximum pressure, maximum normal approach and the contact area dimensions. The formula that describes the dependency between contact force and displacement raised to power of 3/2 proved it's utility in many fields of research. Although Hertz's results were obtained presuming that the contact force rises infinitely slowly from zero, to the nominal value, the equation proved to be viable in elasto-dynamics.

2. Dynamical models of elasto-plastic impact

Timoshenko, [3], accepting the hypothesis that in dynamic conditions, Hertz's equations are still viable, establishes the time of contact, the maximum approach and maximum force when two perfectly elastic spheres with known elastic properties, geometry and relative speed collide. Hunt and Crossley, [4] found the condition imposed to damping force equation, so that the hysteretic curve should close in origin point. They demonstrate that the damping force equation must be:

$$F_a = c\delta^{\frac{3}{2}}\dot{\delta} \tag{1}$$

where F_a is the damping force, δ is the normal approach between the two colliding