Prediction of the Metric Thread Quality After Axial Thread Rolling Process on Cold Using of Finite Element Methods

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Abstract. The article concerns the possibility of predictions the quality of a cold-rolled thread using numerical methods. An application was developed in the ANSYS/LS-Dyna program in APDL language for simulation of displacements, strains and stresses in the thread during and after the rolling process for various machining conditions and material type. The thread rolling process was treated as a physically and geometrically nonlinear initial and boundary problem with unknown boundary conditions in the contact zone. The object motion equation was adopted for the case of a elastic and visco-plastic body with non-linear hardening. The discrete equation of motion together with the appropriate initial and boundary conditions was solved by explicit method. The example to use the application for the simulation of the thread rolling process of the thread M27×3 is shown. The results of numerical calculations were verified experimentally.

INTRODUCTION

There are two basic ways to perform the thread. The first one is shaping of thread by removal of material from the grooves [2-4] and the second - by the plastic deformation of the material [1-4] on the tread rolling process (Fig. 1). Selecting treatment method depends on the dimensions and outline of the thread, the accuracy requirements for its implementation, the material properties and structure of the workpiece also the production volume.

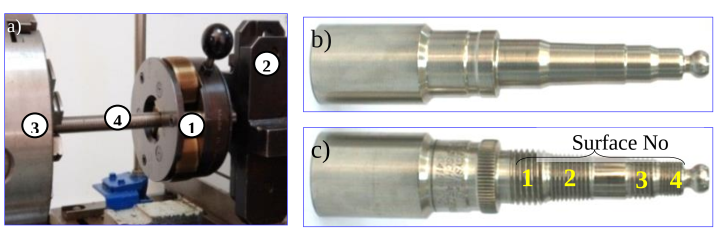

FIGURE 1. View of working stand for the axial thread rolling method by angle head type F3 (FETTE) (a): 1 – thread rolling head, 2 – head holder, 3 – three-jaw chuck, 4 – rolled rod and exemplary workpiece before (b) and after thread rolling process (c)

The aim of this article is prediction of the quality of the thread rolled on cold with use of numerical simulation methods. An application in the ANSYS/LS-Dyna program in APDL language was developed to simulate the states of displacements, strains and stresses in the thread during and after the thread rolling process, for different machining conditions. The results of numerical calculations were verified experimentally.

EXPERIMENTAL INVESTIGATIONS (VERIFICATIONS)

With some approximation and simplification, it can be assumed that the shaping of the thread runs symmetrically. In the initial embossing phase (Figure 2), is a clear difference seen between the displacement of the outside volumes compared to the central part of the profile. This is due to the relatively small penetration of the first kneading rings into the work material, as a result of which their impact on the middle part of the profile is insignificant. As the subsequent rings penetrate, the gradual enlargement of the entire thread profile is observed. Changing the shape and width of the cavity on the crest results from the increase in filling the free space between the roller rings. In this case, the effect of the lubricant is observed, which facilitates material movement along the side surfaces of the rolls, resulting in a slight increase in the height of the thread profile (Figure 2 crest) in relation to dry rolling during which material movement is inhibited (Figure 2 root). In comparison shaping stages of the thread during numerical simulation is shown on Figure 3.

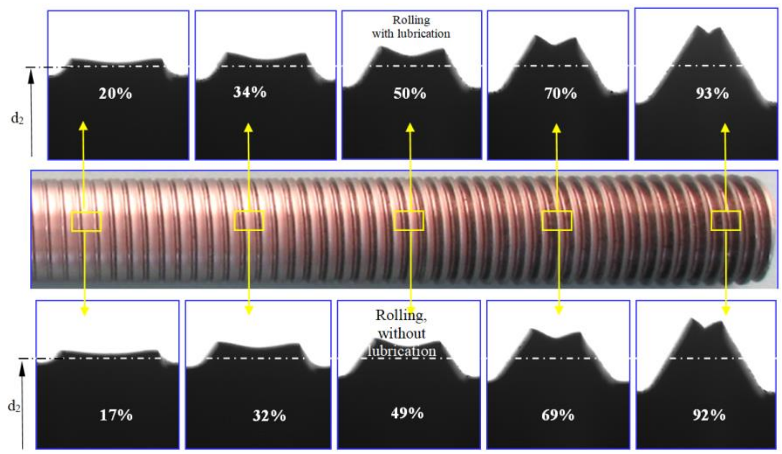

FIGURE 2. View of the sample with a thread at various stages of the process and axial cross-sections of the thread created as a result of impact on the workpiece of subsequent kneading roller rings, during dry rolling (bottom part) and with lubrication (upper part)

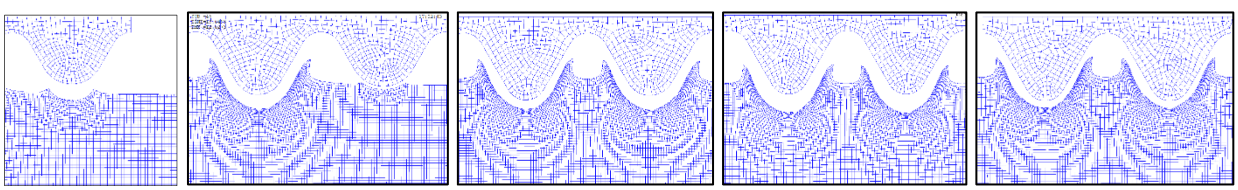

FIGURE 3. Exemplary results for grid deformation during metric thread rolling process for following stages

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