Evaluation of an Experimental Setup Developed For Measuring the Friction Coefficients

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Abstract - In the presented study, an experimental setup was developed in order to measure the friction coefficient and examine the material flow during upsetting. A grid pattern was printed on the side and upper surfaces of ring shaped test specimen, and photos of the final positions of the grids were taken for different upset ratios. Grid deformation views and the standard procedure for friction coefficient determination were used in the analysis of the ring-compression test results. Two different test materials were upset to different ratios in the tests and the friction coefficients for unlubricated conditions were determined. The friction coefficients are harmonious with similar test results as expected. Variation in the grid dimensions with respect to deformation ratios offer a better analysis for the ring deformations.

Keywords: *Friction, Ring - compression, deformation.*

1. Introduction

Determination and evaluation of the friction coefficients is a very important issue due to their effect on the material flow pattern and deformation loads during deformation processes. Ring-compression test is a widely used experimental procedure for the determination of the friction coefficients [1, 2]. The outer and inner diameters and the heights of the rings of the material to be deformed are machined according to 6:3:2 ratio and the change in the inner diameter and height are determined for various deformation ratios; obtained results are then inserted on a standard calibration curves chart in order to determine the friction coefficients [1, 3, 4].

Examination of the variation of the deformation on the rings' surfaces necessary to better analyze the ring compression tests [1, 5, 6]. In order to make a quantitative analysis, a grid pattern is drawn on the side and upper surfaces of the rings and photos of the final positions of the grids are taken for different upset ratios. Grid deformations and the determination procedures of the standard friction coefficient can be used in the analysis of the ring-compression tests. Test specimen were machined with two different testing materials as commercially pure aluminum and Ms 58 Brass, and were upset with different ratios under unlubricated conditions. The results are harmonious with similar test results as expected.

2. Experimental Procedure

An experimental set-up was designed and manufactured in order to perform the ring-upsetting experiments. The dies were machined from H13 hot-wok tool steel and hardened to a level of HRC 54. For other parts of the set-up, the specimen was placed on the die halves concentrically and they were machined from medium carbon steel in order to keep them aligned. The related parts and their alignment of the experimental set up are given in Figure 1.

The ring shaped test specimens were machined from commercially pure aluminum and Ms58 brass rods in 16 mm diameter with 8 mm inner diameter and three different heights; 5 mm, 8 mm and 16 mm. The grid lines of 2 mm spacing were printed on the upper and cylindrical side surfaces of the specimen. The specimen and the grids are shown in the Figure 2.

Figure 1: Experimental set-up photos

Figure 2: Test specimen and the grid lines (The ones on the left are Aluminum and the right are Brass)

3. Experimental Results

Ring compression tests were carried out at the civil engineering material test laboratory of Istanbul Aydin University with a 1000 kN Universal tension-compression test machine at 1 mm/min test speed in unlubricated conditions. The specimen's photographs were taken before and after each upsetting operation, and heights were measured and recorded. A typical load-displacement curve photo is given in Figure 3.

The inner and outer diameters and heights of the ring specimen were measured and checked from the photos taken. The results were inserted into the standard ring compression calibration curves that were taken from literature and digitalized as MS Excel curves. The results are shown in Figure 4. Side views of the test specimen are given in Figure 5. The grid deformations can be seen in the photos.

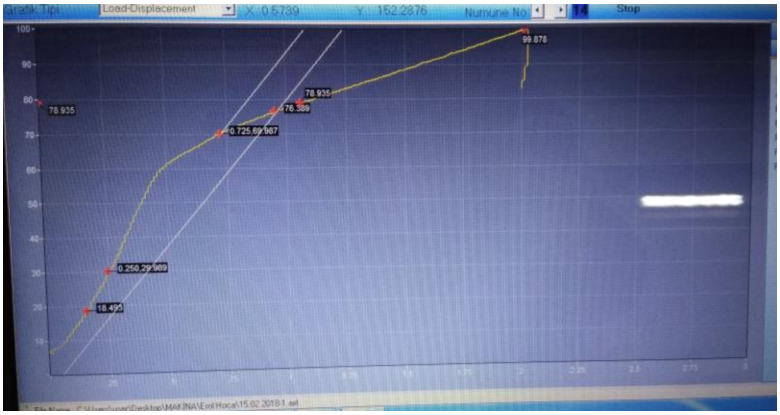

Figure 3: A typical Load-displacement print-out from testing machine.

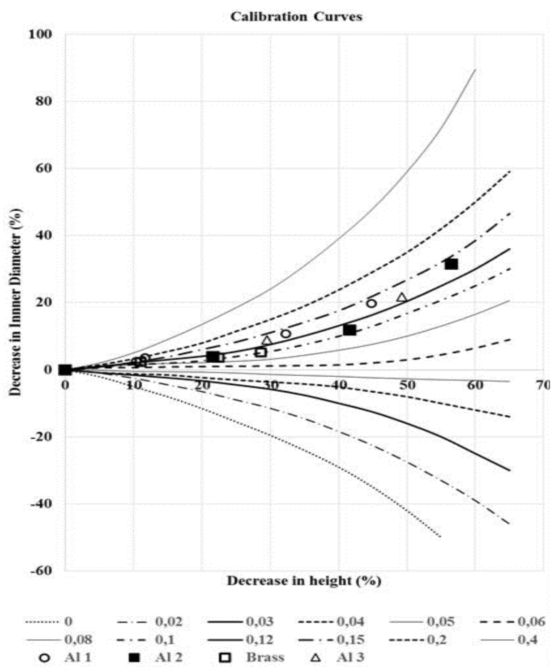

Figure 4: Calibration curves and ring-compression test results.

Figure 5: Side grid photos of the ring specimen.

As it can be seen in Figure 4, the friction coefficient values lie between μ 0,1 and 1,15 which are normal for unlubricated, dry friction of metal to metal contact conditions. The experimental results are harmonious with the literature indicating that the experimental set-up and the used procedure are acceptable for such works.

4. Conclusions

In the presented study, an attempt was made to obtain material flow pattern and friction coefficients in ring compression standard test. The experimental results are harmonious with the literature. The grid measurements and their evaluation have a potential in the deformation analysis studies.

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