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INFLUENCE OF MECHANICAL PARAMETERS ON WAVE EFFECTS OF PLASTIC YIELDING LOCALIZATION OF ALUMINIUM-MAGNESIUM ALLOY: THE APPLICATION OF DIGITAL IMAGE CORRELATION

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ABSTRACT

The present work outlines results of complex experimental investigation of aluminium-magnesium alloy behaviour at elasto-plastic and postcritical deformation stages by using the DIC technique. Wave front of plastic strain during yield drop and plateau forming was captured and estimated. Elicited an influence of mechanical parameters (sample geometry, tension speed, stiffness of loading system) on wave effects of plastic yielding localization. This investigation shows staging in mechanisms of plastic flow in materials under uniform loading.

Keywords: experimental mechanics, digital image correlation, wave effects, plastic yielding localization of material, aluminium-magnesium alloy.

INTRODUCTION

For projecting and numerical model's development of structures should be taken into the account not only mechanical and strength characteristics of materials, but also its behavior singularity. There are a lot of studies concerning the deformation and fracture processes in materials, occurring irregularly on all scales of observation: micro-, meso- and macroscales.

The present work deals with experimental research of macroscopic plastic strain localization effects during uniaxial tension of aluminium-magnesium alloy. Striking examples of these effects are Chernov-Lüders Lines, waves' initiation and evolution of localized plastic strain. With the aim of investigation of material behavior on elasto-plastic and postcritical deformation stages was used the effective non-contact, computer-vision-based, specimen surface displacement and strain fields measuring method by correlating digital images before and after loading - a digital image correlation technique (DIC).

Tests were conducted on the universal servo-hydraulic biaxial test system Instron 8850 with using a three-dimensional digital video system Vic-3D. The system includes two pairs of digital monochrome DCD cameras (1.4 and 4.0 Mp resolution), special software for taking and postprocessing pictures, lighting systems, synchronizing module and calibration grids.

The main purpose of this research was to estimate how mechanical parameters (sample geometry, tension speed, stiffness of loading system and etc.) influence on wave effects of plastic yielding localization of material in conditions of macro-uniform deformation. Flat and cylinder dog-bone specimens were made of aluminium-magnesium alloy (Mg 2.2%, Mn 0.6%, Fe 0.4%, Si 0.4%).

RESULTS AND CONCLUSIONS

The given table shows only a part of testing program which was worked out. As an example, the results from uniaxial tension of flat dog-bone specimen with 10 mm width, 50 mm length and 1.9 mm thickness are presented in Fig.1. Numerous teeth on load-displacement diagram are a reason of interrupted deformation effect that is typical for aluminum alloys. On elasto-pastic stage of deformation were fixed and determined evolution of displacement and strain fields by using the DIC technique. A wave front of plastic strain was captured by using the VIC-3D system during yield drop and plateau forming. The example of heterogeneous axial strain field is shown in Fig.2.

Table 1 Uniaxial tension test program

Mechanical parameter	Sample shape	Width, mm	Length, mm	Tension speed, %/min
Geometry	Flat	10	50..125	5
	Flat	10..25	50	5
	Cylinder	10	50..125	5
	Cylinder	10..15	50	5
Speed	Flat	10	50	1..50

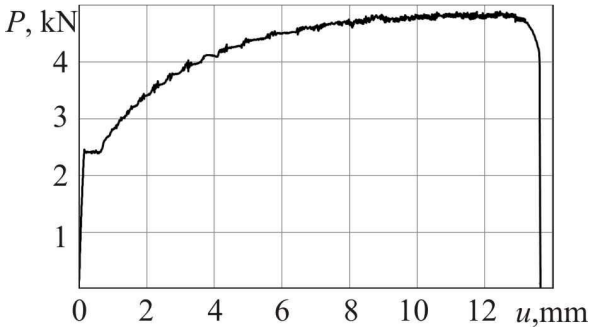

Fig. 1 - Uniaxial tension of the flat aluminum sample

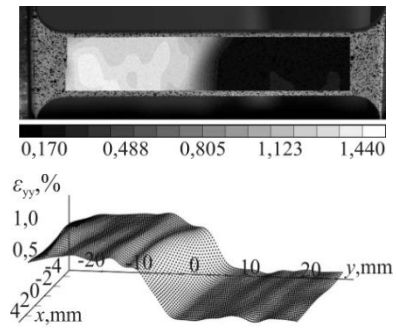

Fig. 2. - Wave front of plastic axial strain on sample surface, fixed by using the DIC technique

The experimental data were used for formulating model approximations of wave processes and space-time inhomogeneity, which were running at different stages of the aluminium-magnesium alloy deformation. This investigation shows staging in mechanisms of plastic flow in materials under uniform loading. The non-contact and nondestructive optical method is accurate, high-efficient and useful in such research issues. Complex study of deformation and failure processes is one of the most popular and important direction in Experimental Mechanics, and also demands a developing of test procedures and numerical models.

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REFERENCES

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