

P. SKUBISZ^{a,*}, A. LUKASZEK-SOLEK^aEFFECT OF PROCESSING CONDITIONS ON FORGEABILITY AND PROPERTIES OF
HOT AND WARM-FORGED STEEL 300M

Results of investigation of the effect of processing conditions of medium-carbon alloy steel AISI 300M on forgeability and microstructure-properties are presented here, including as-forged and heat treated condition of the material. The presented results concern two vital aspects of plastic forming of high-duty impression-die forgings, which underlay a selection of technological conditions which enable the accomplishment of the required quality of the forged part. These are: firstly, the microstructure and mechanical properties and their uniformity within a part and secondly, technological realization of forging the required geometry in the given processing conditions.

In order to define a favourable processing window, dynamic behaviour modeling in variable forging conditions was carried out, establishing a coefficient of energy dissipation $\eta\%$ and the metal flow instability areas, which indicated the temperature regime and strain rate range for the forging process. The constructed processing maps were subject to experimental verification in the die-forging tests, carried out on a screw press. Hot and warm forging conditions were applied accordingly to selected areas of the processing maps, representative for unique forging conditions occurring in the industrial practice.

Keywords: warm forging, processing maps, steel 300M, forgeability, dynamic material modeling

1. Introduction

Steel 300M is an advanced grade of medium carbon ultra-high strength steel referred to as ultra-high strength steel, whose composition, besides superior strength properties, is designed to amend for insufficient level of some operational characteristic, e.g. fracture toughness and/or cracking resistance. Owing to high strength, 300M steel is typically used in applications where superior strength properties are required, e.g. aircraft landing gears, airframe parts, fasteners, gears, transmission system components, pressure vessels etc [1,2].

Significant fraction of the applications are complex geometry parts, manufactured through forging techniques. Like other high strength steels, 300M is typically hot-forged [3]. Hot forging does not enable high accuracies to be achieved without coining, strengthening or calibration. Due to its chemistry, this steel is prone to decarburization while soaking at elevated temperatures. Therefore, machining was used after normalizing annealing to attain the final properties.

In many cases, accuracy and quality problems witnessed in hot forging can be reduced by the application of warm forging regime. As a rule, forging in lower working range is advantageous from the standpoint of net-forging accuracies, promoting material and machining savings, and due to other aspects such as preventing scale formation, excessive grain growth and decarburization

to which grade 300M has a particular inclination [4]. However, successful use of warm forging is conditioned by two major aspects – i) forgeability, and ii) the final microstructure which in warm forging gain more importance. Both of these aspects can be taken into account in dynamic material modelling for the design of the forging process with use of processing maps, which combines macroscopic studies of flow stress dependence on the process conditions with microstructural response, referring to dynamic behaviour of deformed material and stability of plastic deformation [5–7]. The presented study concerns two vital aspects of plastic forming of high-duty impression-die forgings, which underlay selection of the technological conditions which enable accomplishment of the required quality of the forged part. These are: firstly, the microstructure and mechanical properties and their uniformity within a part, and secondly, technological realization of forging the required geometry in the given processing conditions.

2. Experimental

2.1. Material characterization

As-received steel 300M in the form of a hot-rolled bar was used in the study. The chemical composition of the grade used in the study is presented in Tab. 1. The experiment was preceded

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Evaluating The Forgeability Of Steel 2nd Edition

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