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A NEW VERSION OF HOPKINSON BAR TESTING STAND FOR DETERMINATION OF DYNAMIC TENSILE CHARACTERISTICS

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1. Introduction

There is an increasing demand for determination of tensile characteristics of engineering materials under static and dynamic loading in order to assess an influence of the strain rate on their course. The paper presents a new testing stand for tensile characteristics determination under dynamic loading covering strain rate range up to 5000 1/s. This device was used to determine the stress-strain curves of the TRIP and DP steels. They have been determined for the materials in the as-received state as well as for the same materials after preloading due to fatigue.

2. Details of the testing stand

A construction of the testing stand was based on the technology proposed by G.H. Staab and A. Gilat [1]. The device (Fig. 1) consists of three independent mobile steel parts that are connected together in one rigid unit. There are 7 fences mounted on the device foundation. Thanks to them two 20 mm diameter rods (first stretching and second freely moving) made of 7075-T651 aluminum alloy may move freely, and assure simultaneously mutual alignment of them. A stretching specimen is fixed between the rod according to standard [2].

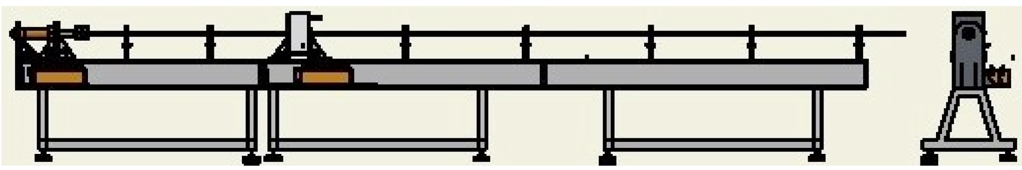

Fig. 1. A scheme of the testing stand for dynamic investigations of materials subjected to tensile loading.

The stretching rod has a length of 3.6 m, and its first tip is connected loosely to the piston of the hydraulic actuator, Fig. 2, which introduces a force giving tensile stress in the range of 20–30 kN. At a distance of 1.6 m from the hydraulic actuator there is a hydraulic lock (Fig. 3). It enables fixing of the stretching rod by clamping jaws before an introduction of the tensile force. A value of this force is measured by means of a special sensor synchronized with the hydraulic actuator. The freely moving rod with a length of 2.2 m, is embedded loosely in the teflon frames, and joined with the stretching rod through the fixed specimen. The whole unit is designed and constructed in such a way that enables to fit a special furnace of the temperature capacity up to 1000°. However, in such high temperature a special material for rods should be applied.

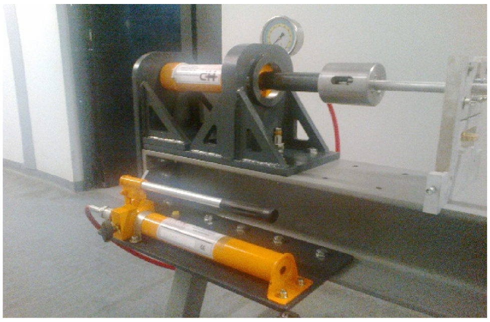

Fig. 2. A general view of the hydraulic actuator connection to the stretching rod.

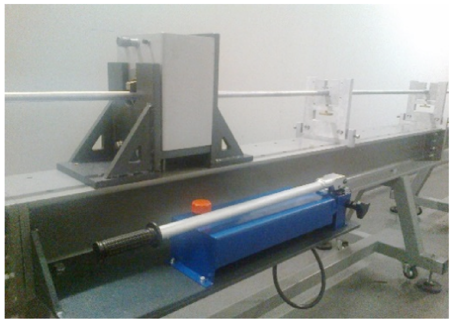

Fig. 3. Hydraulic lock.

3. Results

Two kinds of steel, i.e. DP560 and TRIP690, were investigated in a wide range of strain rates ranged from 0.005 1/s to 2000 1/s. The results are presented in Fig. 4. The standard servo-hydraulic testing machine was used for tests under quasi-static loading conditions, while for the dynamic ones the Hopkinson bar testing stand was applied [3–5]. Both materials exhibited substantial sensitivity in to the level of strain rate. After analysis of the captured characteristics one can conclude that a stress responses in the plastic range increase with the strain rate increase. Also the elongation takes higher magnitudes.

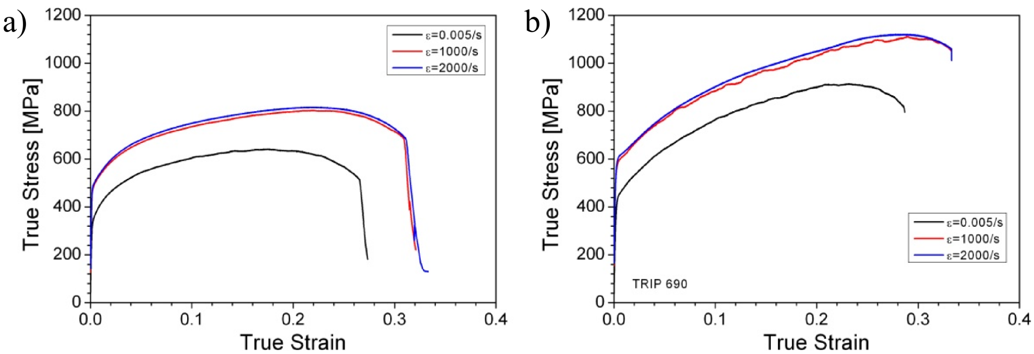

Fig. 4. Comparison of the tensile characteristics for a range of strain rates, the results for: a) DP 560 steel; b) TRIP 690 steel.

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