PRELIMINARY EFFICIENCY ANALYSIS OF ANN MODELLING OF COMPRESSIVE BEHAVIOUR OF METAL SPONGES

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1. General

Porous metallic materials are one of the most interesting class of modern engineering materials, which find applications in a wide range of fields, like: medicine (implants), transportation (plane coatings, car bumpers), energy industry (batteries) etc [1]. Depending on the type of porosity, they can be classified to different subgroups, e.g. open-cellulars, closed-cell metallic materials, gasars, sponges (open irregular porosity) and others [2]. The authors would like to present here a study on open-cell aluminium.

The material was produced in own laboratories and its properties were investigated in uniaxial compression experiments. An ANN analysis was performed in attempt to modelling of the compressive behaviour of own aluminium open-cell material.

2. The material and uniaxial compression tests

The material was not bought from an external supplier, but was self-produced [3]. The parameters of the production method were calibrated in course of the manufacturing, so there were two sample groups obtained: the prototype group (with some minor structural imperfections and generally larger relative densities) and the regular group (without structural mistakes, with smaller relative densities). Both groups were then subjected to uniaxial compression [3–5]. The experiments showed that compressive response was related to samples' density (Fig. 1).

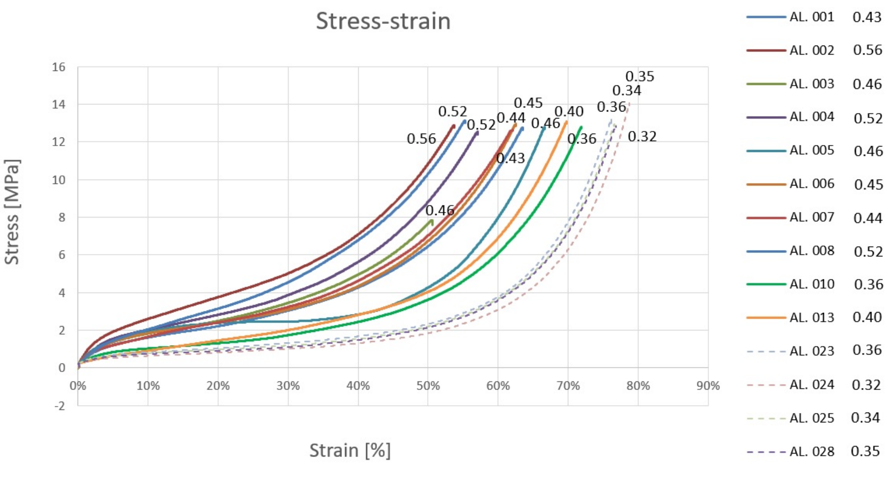

Figure 1: Stress-strain diagram for open-cell aluminium samples (the numbers by plots are relative densities in [g/cm^3]).

3. The ANN analysis

The computational analysis aimed at modelling of the aluminium sponge compressive response with relation to its density. The method chosen was an artificial neural network analysis [6, 7].

The calculations were performed using Matlab R2011B version. All data were taken from the conveyed uniaxial tests for all samples for the range $\sigma = 0 \div \sim 3$ [MPa]. The input data for the ANN analysis were in this case pairs of numbers for each sample: strain and density. The output was the stress. Measurement data processing was performed using a two-layer feedforward neural network implemented in Matlab environment. The first layer was the hidden layer, the second was the output layer. In detail, the ANN procedure consisted of training, validation and test.

Fig. 2 depicts the created neural network structure. It had one hidden layer consisting of 3 neurons; there were no delays implemented on the input for this layer. The activation function for the hidden layer was tangensoidal (tansig). The output layer had a linear activation function. The obtained results showed that the assumed neural network is capable of modelling of the compressive behaviour of the given material with relation to its density for the assumed stress range: the obtained regression for all data was R=0.966. The regression chart and the histogram error plot are presented below (Fig. 3).

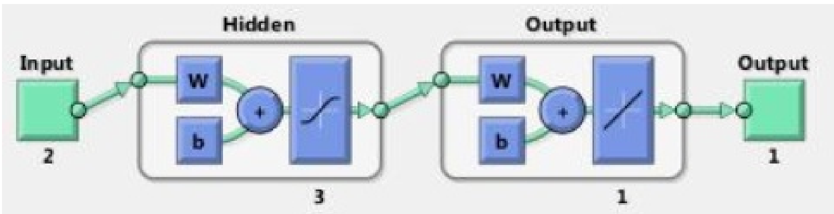

Figure 2: ANN structure.

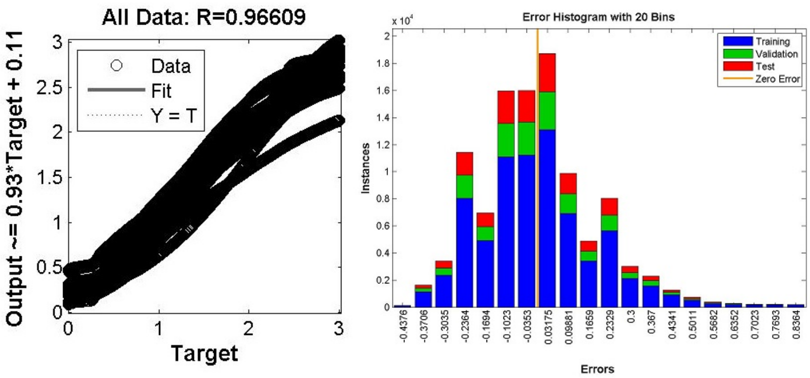

Figure 3: Regression and error histogram for the ANN.

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