FATIGUE BEHAVIOUR OF DUCTILE CLOSED-CELL ALUMINIUM ALLOY FOAMS

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Abstract: This work investigates the fatigue response of a class of ductile closed-cell aluminium alloy foams known by their commercial name Alulight M8. Fatigue tests were performed in uni-axial compression on cylindrical specimens of 25 mm diameter and 25 mm height with an R ratio of 0.1, at a frequency of 10 Hz. The peak stress was varied from 90% to 135% of the yield stress in compression. Tested specimens were cut from the same cylindrical bar and the density of the investigated material was 500 kg/m^3 ±10%, a total of 16 specimens being investigated.With the gathered experimental data, S–N curves were generated, the effect of cellular structure (e.g. structure irregularity-as the number and the size of large or small cells) being discussed.

Keywords: Fatigue, Closed-cell aluminium foams, Compression-compression cyclic tests, Plastic collapse, Structure irregularity.

1. Introduction

Over the past decades, the use of aluminium foams has experienced a rapid growth mainly due to their applications as core components in sandwich structures. Because of the widespread use of aluminium-core panels as structural components in various industrial fields where they can be subjected to complex loadings during service (such as aerospace and automotive industries), the determination of the fatigue behaviour of aluminium foams represents an important aspect in designing new composite structures.

So far, a reduced number of studies have been conducted on the fatigue behaviour of metallic foams, therefore, a fundamental understanding of the fatigue and failure of aluminium foams is required [2]. Thus, an experimental investigation on the fatigue behaviour of closed-cell aluminium alloy foams was performed, by: (i) performing a complete analysis of the fractured surfaces, (ii) conducting investigations on the irregularity of cell structure and finally (iii) plotting of the stress-life (S–N) curve.

2. Results and discussions

It was observed that the fatigue-induced damage in the studied material was caused by the occurrence of degradation bands in the region of the specimen that exhibited the lowest density.

In order to highlight this phenomenon, a layer of black paint was applied on the specimens prior to testing, the local failure determining white shades on the surface (Fig. 1). This mechanism can be further observed by analysing the compressive strain variation with the number of cycles as it produces a significant increase in deformation (Fig. 2).

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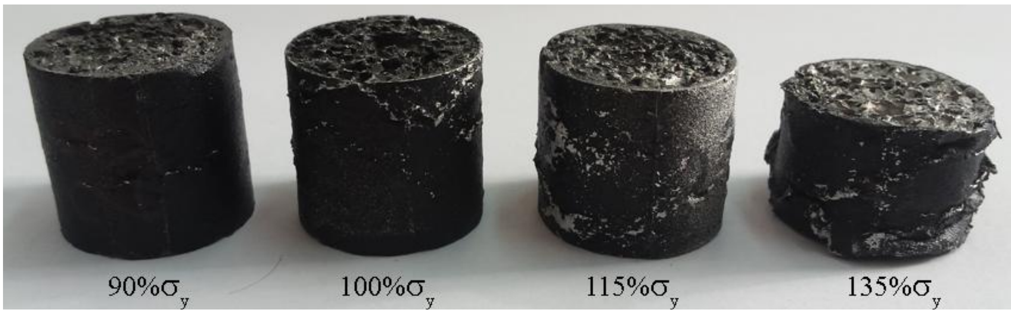

Fig. 1. M8 Aluminium foam specimens after fatigue tests exhibiting degradation bands

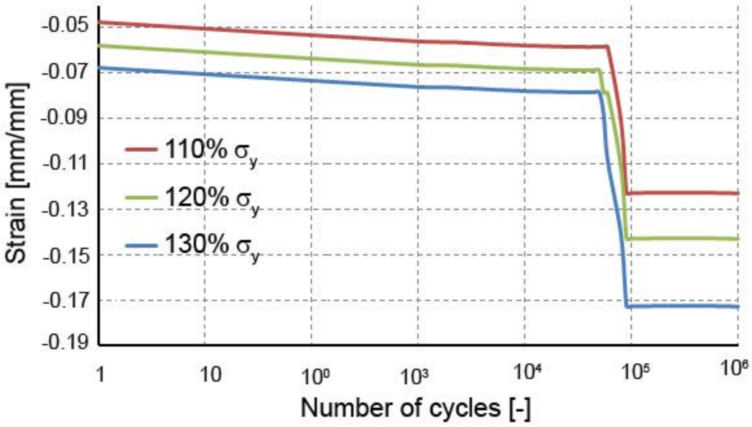

Fig. 2. Nominal strain increase of M8 Aluminium foam with the number of cycles

3. Conclusions

- The stress-life (S–N) curve of the aluminium foam is obtained experimentally.
- Large scatter of fatigue life of the closed-cell aluminium foam is observed and fracture surface is examined.
- The fatigue life decreases as the number and the size of large cells increase.
- The scatter of fatigue life is all the greater as the irregularity of cell structure is higher.

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