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Study on Dynamic Energy Absorption Ability of Closed-cell Si-Al Foam Metals Considering Geometry Size

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Abstract: Geometry size has a great influence on energy absorption ability of closed-cell foam metals. Study on energy absorption ability of closed-cell Si-Al foam metals considering geometry size by impact experiment method. The results show that the strain and absorbing energy value are decreasing with the geometry size increasing, and also lead to the hole wall rupture or whole instability. The best height-width ratio for cube and cylinder are 1.0–1.5 and 1.0–2.0, respectively. With the increasing of material diameter, the compressive strength increasing quickly, but the strain reduces. It is clearly that height-width ratio 1.0 is better for cube and cylinder.

Keywords: geometry size; closed-cell foam metals; impact experiment; energy-absorption

1 Introduction

Foam metals can be considered by mutual connection rod or plate consisting of numerous cell hole unit materials[1]. Geometry size has a great influence on energy absorption ability of closed-cell foam metals. As a new structural and functional material, foam metals which posses good energy-absorption capability is being paid much more attention in the world and found application in many industrial fields such as general industrials, aerospace, automobile and shipbuilding industries[1−3]. Gibson L J and Ashby M F[2] have a research on the structure and property. Then, Banhart J[3] has a theoretically and experimental study on structure, mechanical properties and applications of foam metals. McCullough[4] had a deeper study on static compression properties of matrix Al-Mg1-Si0.6 and matrix Al-Mg1-Si10 CCAF. LU Zi-xing and GUO Yu[5] had a brief review of studies on the mechanical behavior of metallic foams, and discussed the energy absorption property of

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porous metal[6,7]. YU Ji-lin[8−10] also has carried out many research work on the mechanical behavior of foam materials, and achieved good achievement. However, previous research focused on size effect of the mechanics properties of foam metals. the study on dynamic compressive energy absorption properties of foam metals considering geometry size is rare, and the mechanism for compressive energy absorption remains unclear. So the study energy absorption ability of closed-cell Si-Al foam metals considering geometry size by impact experiment method is of far reaching importance. The results provide a scientific basis for the choice of energy absorption material.

2 Impact Experiment

2.1 Experimental equipment

Adopting concussion of testing machine(9250HV), the quality of drop hammer is 7kg–30kg, and the impact velocity is 3m/s–10m/s. By impact test, the relation curves of stress-strain[11,12] and energy absorption can be received. Fig.1 shows the impact experiment device.

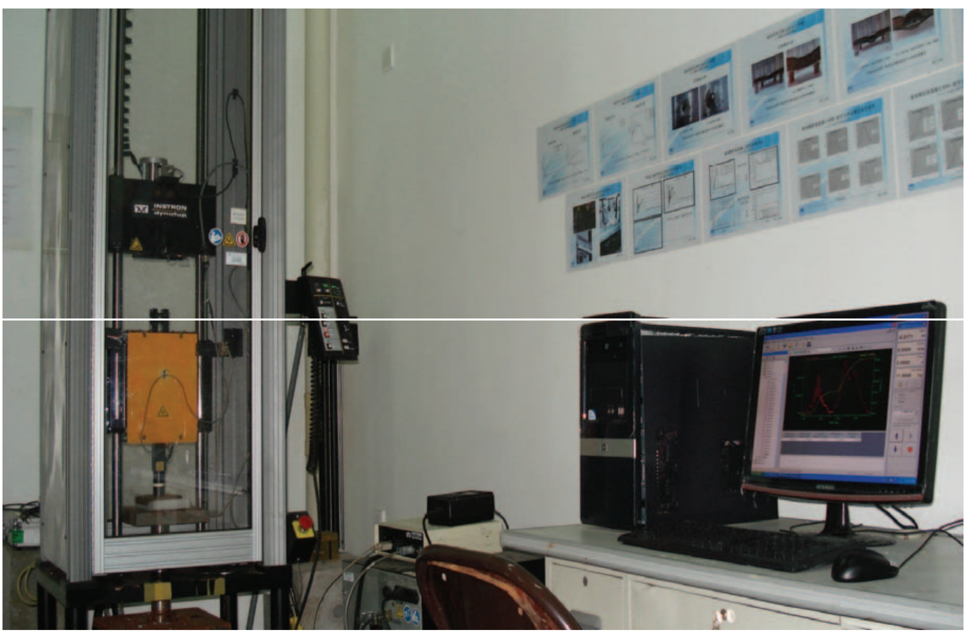

Figure 1: Impact experiment device

2.2 Experimental Materials

When diameter ratio of thick greater than 6, sample own size effect can eliminate. The diameter is about 2.5mm, the minimum thickness for 30mm, so the size effect can eliminate. Experimental materials are matrix Al-Si6 closed-cell foam metals, and the size are 30mm×30mm×30mm, 30mm×30mm×45mm, 30mm×30mm×60mm, 30mm×30mm×90mm, ¡é30mm×30mm, ¡é30mm×45mm, ¡é30mm×60mm, ¡é30mm×90mm, ¡é45mm×30mm, ¡é45mm×45mm and ¡é60mm×60mm, respectively. Experimental materials are shown in Fig. 2.

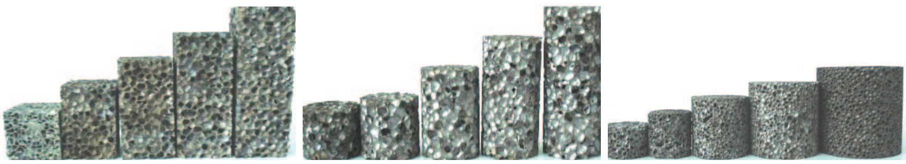

Figure 2: Experimental material sample

3 Impact Experiment Results and Analysis

3.1 Energy Absorption Analysis of Cube Material

According to the experimental results, stress-strain curves of different size materials have the uniformity. All represent elastic stage is more apparent, and the stress reaches the peak suddenly drops. The strain and absorbing energy value are decreasing with the geometry size increasing, and also lead to the hole wall rupture[12] or whole instability. The best height-width ratio for cube is 1.0–1.5. Fig.3 and Fig.4 indicate the relation curves of stress-strainand energy absorption of different size materials.

3.2 Energy Absorption Analysis of Cylinder Material

Based on the experimental results, it is clearly that the represent elastic stage is more apparent, and the stress reaches the peak suddenly drops. The relation curves of stress-strain for cube material are similar as the cylinder material. With the increasing of material diameter, the compressive strength increasing quickly, but the strain and absorbing energy value reduce by the relation curves of energy absorption. It is clearly that height-width ratio 1.0–2.0 is better for cylinder. The relation curves of stress-strain and energy absorption of different size materials are shown in Fig.5 and Fig.6.

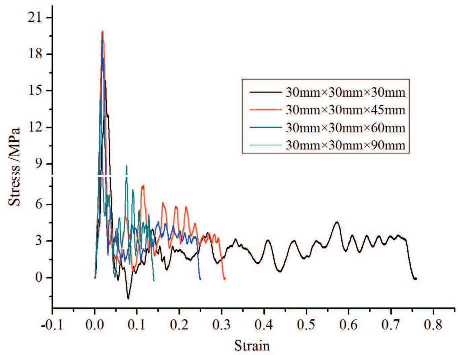

Figure 3: Relation curves of stress-strain(cube)

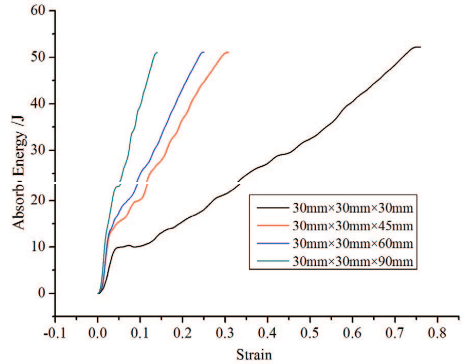

Figure 4: Relation curves of energy absorption(cube)

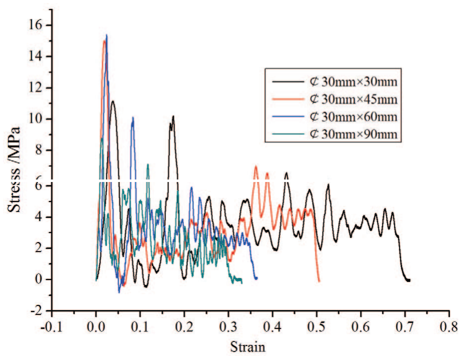

Figure 5: Relation curves of stress-strain(cylinder)

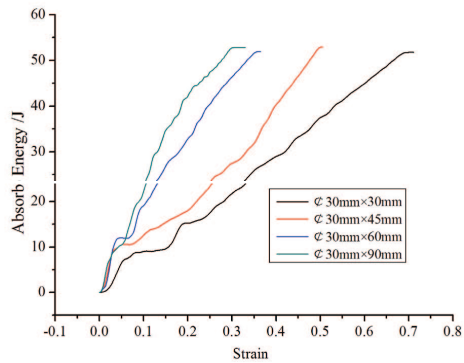

Figure 6: Relation curves of energy absorption(cylinder)

3.3 Impact Energy Absorption Analysis of Different Diameters

Fig.7 and Fig.8 indicate that the relation curves of stress-strain and energy absorption of different diameters materials. By the experimental results, it is clearly that stress-strain relationship is consistent, elastic stage obvious, compressive strength value bigger, while sucking value bigger also. With the increasing of material diameter, the compressive strength increasing quickly, but the strain reduces. It is clearly that height-width ratio 1.0 is better for cube and cylinder.

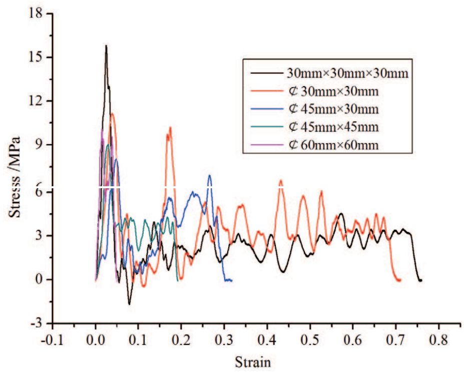

Figure 7: Contrast curves of stress-strain

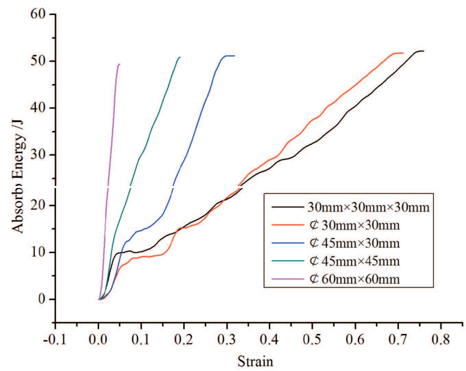

Figure 8: Contrast curves of energy absorption

4 Conclusions

According to the study on energy absorption ability of closed-cell Si-Al foam metals considering geometry size by impact experiment method. The main conclusions are as follows:

(1) The strain and absorbing energy value are decreasing with the geometry size increasing, and also lead to the hole wall rupture or whole instability. The best height-width ratio for cube and cylinder are 1.0–1.5 and 1.0–2.0, respectively.

(2) With the increasing of material diameter, the compressive strength increasing quickly, but the strain reduces. It is clearly that height-width ratio 1.0 is better for cube and cylinder.

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