Advanced Science and Technology Letters
Vol.120 (GST 2015), pp.252-256
http://dx.doi.org/10.14257/astl.2015.120.51

Simulation Analysis of Mechanical Characteristics of Adhered Aluminum Foams with Varying Thickness Under Compressive Force

Jung Ho Lee[1], Jae Ung Cho[2]

[1] Department of Mechanical Engineering, Graduate School, Kongju National University, 1223-24, Cheonan Daero, Seobuk-gu, Cheonan-si, Chungnam of Korea 31080, jungholee8@kongju.ac.kr
[2]Corresponding Author Division of Mechanical & Automotive Engineering, Kongju National University, 1223-24, Cheonan Daero, Seobuk-gu, Cheonan-si, Chungnam of Korea 31080, jucho@kongju.ac.kr

Abstract. This study performs a simulation analysis of the mechanical characteristics on three models of adhered aluminum foams with varying thickness under compressive forces. As a result, the equivalent stress reached the yielding point at a compressive displacement of 5mm, and the stresses for the specimen thicknesses of 20, 40 and 60mm were 1.03, 1.04, and 1.05MPa, respectively. The ultimate failure of model occurred at the displacement of 33.5 mm for the specimen thickness of 40mm, and the model with the specimen thickness of 60mm failed at the displacement of 35mm. The reaction forces showed that the maximum reaction force was reached when the displacement was 5mm, and the reaction forces for the specimen thicknesses of 20, 40 and 60mm were 2010, 4040, and 6100N in order of specimen thickness.

Keywords: Aluminum Foam, Compressive force, Adhesive, Finite element analysis

1 Introduction

This study aims at evaluating the mechanical characteristics of the aluminum foams of closed cell type through simulation analyses. A cubic model was made by using the 3D CAD program of CATIA and the structural analysis was performed through ANSYS, the common finite element analysis program.

2 Analysis Conditions

In order to have thickness intervals of 20, 40, and 60mm, a cuboid model with a height of 100mm, width of 100mm, and a thickness of 20mm were overlapped to

ISSN: 2287-1233 ASTL

make the analysis model. On the attaching surface, the command language of ANSYS was applied to model the characteristics of the adhesive. The result will differ from the regular contact region settings because the analysis will be performed with the assumption that the adhesive is applied. The models used in the analysis are shown in Fig. 1 [1].

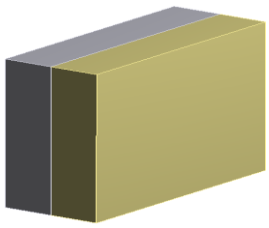

Fig. 1. Analysis model with the specimen thickness of 40mm

The bottom face is fixed and the compressive force is applied downwards from the top [2]. Therefore, the bottom face was under the condition of fixed support while the compression acted downwards on the top face with the displacement applied on the –z direction. The connections were set as the frictionless condition, allowing the slippage between elements. The analysis conditions are shown in Fig. 2 [3].

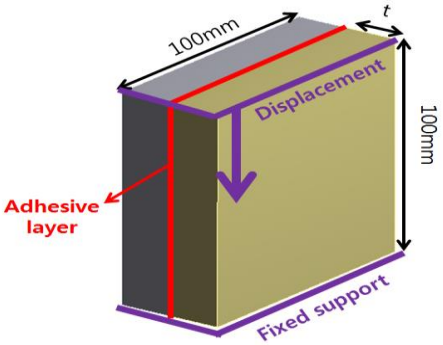

Fig. 2. Analysis conditions

3 Analysis Results

3.1 Equivalent Stress Results

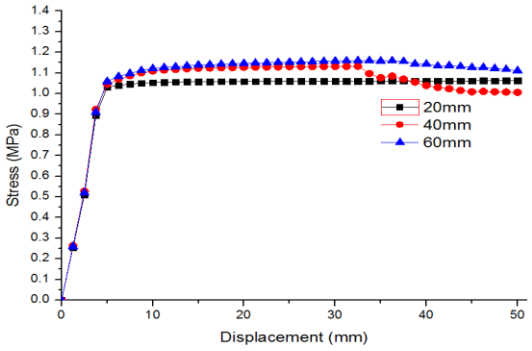

Fig. 3. Equivalent stress vs. compressive displacement for each model

The equivalent stress due to compressive displacement is shown in Fig. 3. The equivalent stress increases rapidly until it reaches the yielding point at the displacement of 5mm. The equivalent stresses at the yielding point were 1.03, 1.04, and 1.05MPa for the specimen thicknesses of 20, 40, and 60mm, respectively. After it becomes the plastic state, the equivalent stress increases slightly until the displacement reaches 33mm. At the displacement of 33.5mm, the equivalent stress at the specimen thickness of 40mm begins to decrease. Then, the equivalent stress for the specimen thickness of 60mm begins to decrease at the displacement of 35mm. With aluminum foams with the closed cell type, the internal pores are crushed as compressive forces are applied and it seems that the internal pores are entirely crushed for the specimen thicknesses of 40mm 60mm at the displacements of 33.5mm and 35mm, causing the ultimate failure. As shown by the stress analysis, the models for the specimen thicknesses of 40mm and 60mm have the decreased stress in the plastic state while the specimen thickness of 20mm do not.

3.2 Reaction Forces Results

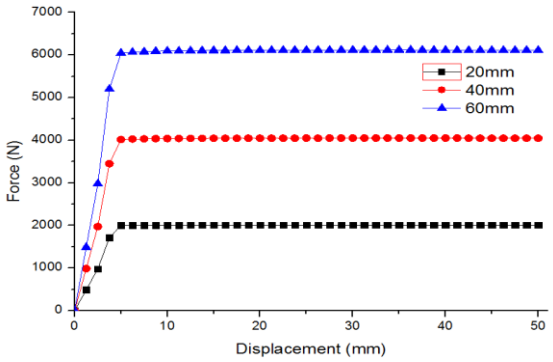

Fig. 4. Reaction force vs. compressive displacement for each model

Fig. 4 shows the reaction force at the fixed bottom surface due to the compressive displacement. As with the equivalent stress, the reaction forces increase rapidly until the displacement reaches 5mm. After it peaks, it maintains the constant value. This constant value of force was 2010, 4040, and 6110N for the specimen thicknesses of 20, 40, and 60mm, respectively.

4 Future direction and practical application

Aluminum foam for the closed type is the material with light weight used mainly as the absorbent. This study aims at securing the compressive characteristic of the structure bonded with aluminum foam for the closed type and the data at the condition of low impact. And the study result can be applied practically by verifying the safety. In future direction, it is thought that the data of the compressive and impact characteristics at the more varied conditions through the impact of high speed and the change of the direction progressive due to compression can be obtained.

5 Conclusion

This study performed research on the analysis of mechanical characteristics of adhered aluminum foams with varying thickness under compressive forces. The equivalent stress resulting from compressive stress shows that the models reached their own yielding point at compressive displacement of 5mm and the equivalent stress at that point was 1.03, 1.04, and 1.05MPa for the specimen thicknesses of 20, 40, and 60mm, respectively. The stress begins to increase after it becomes the plastic state until the model with specimen thickness of 40mm reaches the failure at the displacement of 33.5mm and the model with specimen thickness of 60mm reaches

failure at 35mm of displacement. The reaction forces of the three models reached their own maximum point at the compressive displacement of 5mm as did the equivalent stresses, and the reaction forces were 2010, 4040, and 6100N for the specimen thicknesses of 20, 40, and 60mm, respectively. This research can be devoted at improving the safety and the optimal design of aluminum foams.

Acknowledgments. "This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2011-0006548)."
"This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2015R1D1A1A01057607)."

References

1. M. S. Han, H. K. Choi, J. U. Cho and C. D. Cho: Experimental Study on the Fatigue Crack Propagation Behavior of DCB Specimen with Aluminum Foam. International Journal of Precision Engineering and Manufacturing, Vol. 14, No. 8, pp. 1396-1399 (2013)
2. S. S. Kim, M. S. Han, J. U. Cho and C. D. Cho: Study on the Fatigue Experiment of TDCB Aluminum Foam Specimen Bonded with Adhesive. International Journal of Precision Engineering and Manufacturing, Vol. 14, No. 10, pp. 1791-1795 (2013)
3. B. R. K. Blackman, J. P. Dear, A. J. Kinloch, H. MacGillivray, Y. Wang, J. G. Williams and P. Yayla: The Failure of Fibre Composites and Adhesively-bonded Fibre Composites under High Rates of Test Part III Mixed-mode I/II and Mode II Loadings. J. Mater. Sci, Vol. 31, No. 17, pp. 4467-4477 (1996)

