Mariusz RUCHWA

APPLICATION OF ELEMENTS MADE OF METALLIC FOAMS FOR THE STRUCTURAL PROTECTION AGAINST IMPULSIVE LOADS

Keywords: dynamics, impulsive loads, metallic foams, Finite Element Method

1. INTRODUCTION

Specific material characteristics of metallic foams enable the application of elements made of such materials as the protection of structural elements, absorbing the energy of impulsive loads [1].

In many structural analyses concerning the evaluation of protection efficiency against impulsive loads the numerical approach is used. The very important factor of such analyses is the material modeling, not only for structural material but also for other materials as metallic foams. Adequate constitutive formulation of metallic foams should encounter their compressive behavior, plastic limit definition, plastic potential and hardening. Recently many mathematical models for metallic foams are in use, including popular and verified model *Deshpande-Fleck* [2].

2. EXAMPLE OF APPLICATION – NUMERICAL ANALYSIS

The main goal of the example was to present the results obtained with application of metallic foams as the structural protection against impulsive loads. Due to this fact the presentation was limited to numerical analyses performed using the verified material models [3].

The reinforced concrete wall, which can the part of larger structure, covered with three-layer plate with aluminum foam core was analyzed in this study. Two load cases were considered – impulsive wave produced by a blast, and the impact by a small vehicle. The analyses were performed using the Finite Element Method computer code ABAQUS/*Explicit*. For a concrete the *Concrete damaged plasticity* material model was assumed, for reinforcement and external aluminum lining the elasto-plastic model with hardening, and for aluminum foam the *Deshpande-Fleck* model.

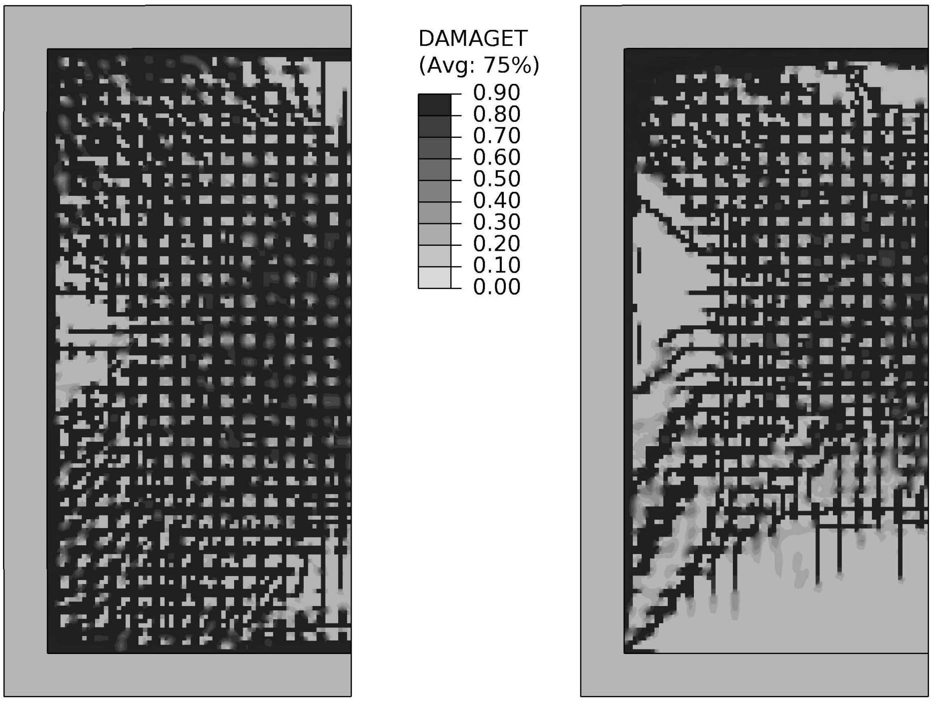

Fig. 1. Distribution of material damages on internal side of the reinforced concrete wall subjected to the blast load. Non-protected wall (left side) and protected (right side).

Example results shown in Fig.1 present the differences between non-protected and protected structure in terms of non-dimensional damage parameter distribution (0 – no damages, 1 – total material damage). The differences in distribution of damages have been observed on the external side and for the variant concerning the impact of the small vehicle.

3. CONCLUSIONS

Simulations described in the work concerning two cases of impulsive loads for non-protected and protected structures show the fundamental differences between distribution of damages in the structures. Observed differences unequivocally show the advantages of metallic foams applied as protection of structural elements against various impulsive loads of different intensity.

REFERENCES

1. Sobczak J.: Kompendium wiedzy o metalowych strukturach komórkowych stosowanych w nowoczesnym projektowaniu technicznym. Wyd. Instytutu Odlewnictwa, Kraków, 1998, (in Polish).
2. Hanssen A.G., Hopperstad O.S., Langseth M., Ilstad H.: Validation of constitutive models applicable to aluminium foams. Int. J. Mech. Sci., 2002, 44, pp. 359-406.
3. Ruchwa M.: Ocena odporności konstrukcji żelbetowej na działanie wybuchu. Biuletyn Wojskowej Akademii Technicznej, 2010, Vol. LIX, 4 (660), pp. 269-280, (in Polish).