Proceedings of the 7th International Conference on Mechanics and Materials in Design
Albufeira/Portugal 11-15 June 2017. Editors J.F. Silva Gomes and S.A. Meguid.
Publ. INEGI/FEUP (2017)

PAPER REF: 6545

SCALING EFFECTS IN THE HIGH VELOCITY IMPACT RESPONSE OF FLAT AND CYLINDRICAL SPECIMENS

T.D. Karimbaev, A.A. Chernyshov(*), A.Y. Ezhov
P.I. Baranov's Central Institute of Aviation Motors, Moscow, Russia
(*)*Emai:*artem@ciam.ru

ABSTRACT

The work carried out experimental and analytical studies of flat and cylindrical specimens of different sizes to accept the principles of the laws of similarity for composite materials by establishing the scale factors in high-speed impact.

Keywords: scaling effects, composite material, fan case, high speed impact, testing.

INTRODUCTION

In accordance with FAR-33 and JAR-E fan case must provide localization of fan blade-out. Currently, the diameters of the fan case reach three meters, making it difficult testing of technical solutions at the stage of the design of the fan case, providing localization fan blade-out. Therefore, without the involvement of small scale models and methods without using the similarity can't be made large-sized detail.

Goals of this work is determination on the basis of analytical and experimental studies scaling parameters in dynamic problems when high impacts and checking the possibility of using a numerical experiment in their samples of various shapes, the samples made of different materials and under different conditions of dynamic effects. The results of observations of the behavior of small samples at high speed impact will allow to predict the effects of the interaction of the impactor with the barrier.

RESULTS AND DISCUSSION

These studies showed that:

- Fracture behavior and deformation of flat samples of various sizes on impact at the same speed, but with energy proportional to n^3 (where n - similarity coefficient), are practically identical;

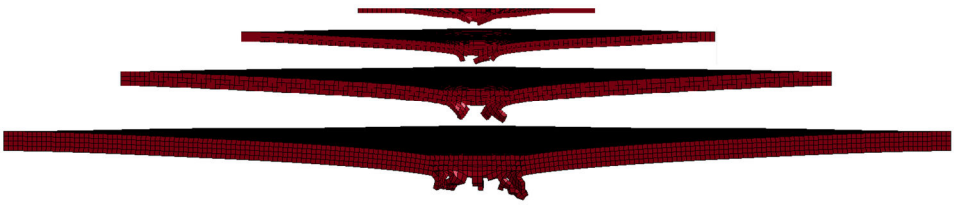
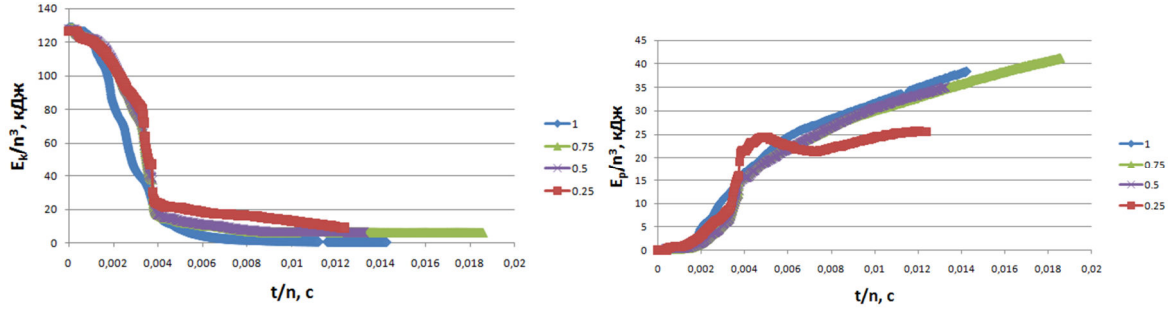


Fig. 1 - Cross sections of samples different sizes after the impact

- Diagrams «normalized» kinetic energy of fan blade $E_к$.vs «normalized» time t traces and «normalized» potential energy of fan blade Ep vs. «normalized» time t traces are similar for all four types of models of body size by taking into account the scale factors;



(a) (b)

Fig. 2 - Diagrams: (a)-«normalized» kinetic energy of fan blade $E_к$ vs. «normalized» time t traces, (b)-«normalized» potential energy of fan blade Ep vs. «normalized» time t traces

- in high-speed impact forms and mechanisms of fracture plates and structurally-similar elements were similar in impact with energies proportional similarity coefficient n;

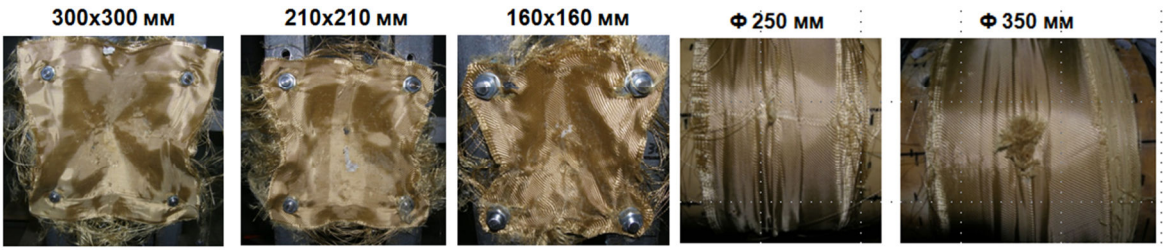


Fig. 3 - Fracture behavior of flat and cylindrical samples after impact

- normalized kinetic energy of impact for almost all tested samples thickness shows the same border of the sample resistance to impact.

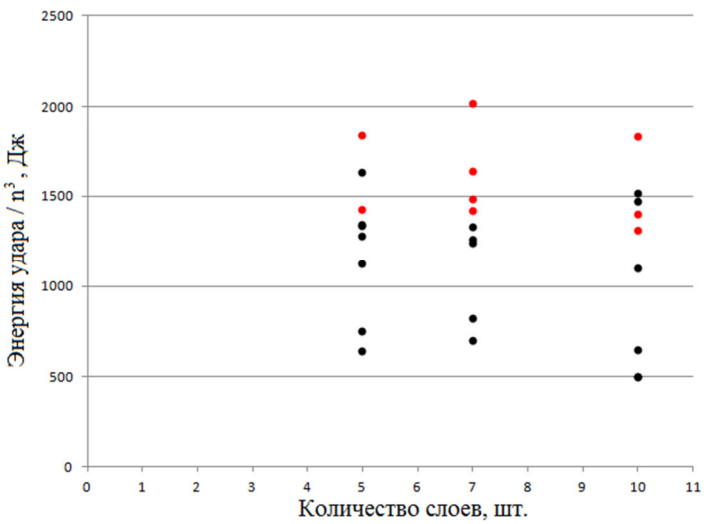


Fig. 4 - Normalized kinetic energy of impact (red points - sample is breached)

These studies allowed to choose the parameters of scaling that allow the results of the study of resistance fan cases of small sizes by blade-out to predict the characteristics of resistance to high impact fan cases of other sizes.