ZRÍNYI MIKLÓS NATIONAL DEFENSE UNIVERSITY
BOLYAI JÁNOS MILITARY TECHNICAL FACULTY
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Modeling of cumulative effect and its simulation by finite element methode

THESIS BROCHURE

Subject leader: Dr. Sipos Jenő PhD
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THE SCIENTIFIC PROBLEM

One way of the process of development, modernisation and optimization of a product consists in creating and applying such informatic methodes ans systems, which integrate electronical, optical and mechanical planning elements and allow simulation of the operation. In this way, from the first step of the design, analysis becomes a basic element of the integration.

Two most important components of a product are cost and profitability. Market also requires competitiveness. In order to be competitive, product has to be produced in high quality and on optimal cost level. This rule applies also in armaments industry.

Beyond of the above mentioned arguments, customers of our days require that product can be displayed before it has been produced, as well as operation and maintenance costs be small. Each oversized element or any unnecessary part increase product costs as material-production-, freight- and general overhead cost. Moreover, weight excess can restrain usage. Above considerations explain product optimization either in civil or in military area.

According to data published by Stockholm International Peace Research Institute in 2009, amounts devoted to armament broke a record of 1,572 Billion Dollars. In our days, global fight against terrorism inspires countries to increase expenses on armament purchases. This can be shown from the database of SIPRI .

Diminution of defense costs can not be expected in the near future, not even if Washington and its allies decide to reduce forces in Iraq, since in this case they would probably increase their forces in Afghanistan.

With the growth of military expenses, some progress in rationalization, economy and efficiency can have been observed. Due to our liabilities of NATO membership and to the armament innovation plan, defense tasks in Hungary are increasing. Necessary sources are assured by the budget, which have to be used efficiently. A press release published on 29th September 2008 confirms: „Budget for 2009 of the War Ministry is modern, economical and transparent. Cost efficiency is extremely emphasized.”

Both cost efficiency and competitiveness are important components which compel companies and developers to innovate and apply new technologies and software.

Subject of my research consists in surveying, computational visualizing of the cumulative effect, and working out a method which allows development of firearms based on this effect.

Function of antitank mines, mine granates and casette shells is based on cumulative effect.

Cumulative granates have been spreaded in the 2nd war. In our days cumulative granates are applied in the cartridge of hand or heavy firearms.

As experienced, cumulative hand- and rifle grenade are able to strike through armours of 100-120 mm, as well as 75-100 mm grenades strike through 250-350 mm, 100-125 mm grenades strike through 400-560 mm, acting from above, case charges 100-150, antitank missiles 500-600 mm , and cumulative antitank shells can strike through 150-200 mm armours.

Cumulative effect is very dependent on the liner material. Most metals have been tested, except those, which are infrequent, expensive or toxic. Alloys have been also tried. As experienced, most liners made of pure metal are more efficient than ones made of alloys. From the same liner materials, fine-crystal materials are better than the rough ones. Tests in this context are still in process.

Loads used in our days are of 38-180 mm caliber. In this interval, proportional enlargement and diminution cannot be applied. Small loads require big precision, and when dimensions are bigger, homogeneous metallurgical characteristics of the liner material can hardly assured. Each construction is unique and can operate in the planned way only with certain dimensions.

Finite element method is widely applied in the military area. One searched subject is transformation of the renewal technology of the artillery and tank copper sheaths, the target of which consisted in avoiding evolution of fissures in the renewed products after some usage time. Based on metallurgical tests of analyzing the abrasion made from fire-cracks, it is evident, that they are of intercrystallin character, which refers to phenomenon of stress corrosion. Corrosion tests proved that the internal tension cumulated in the sheats is not of production origin, but issued in the material during the shooting. This statement was confirmed by the finite element method.

Finite element method can be applied not only for solution of technical problems, but also for simulation of the expansion of ABV materials.

OBJECTIVES OF THE RESEARCH

Tests for cumulative effect are managed by Zrínyi Miklós National Defense University Bólyai János Military Technical Faculty. Experiments and tests executed according to the search plan approved in 2004 have been realized. Objective of this research, beside supporting familiar theories, was mapping of the mode of action by means of different cartridges, and computer aided simulation of the effect with the measured data, supported by an appropriate software.

According to the conception, tests can be divided to processes which can be analyzed dependently or independently from each other.

Objective of the research consists in processing results of experiments made with different types of cumulative charges. The experiment analyzes effects of well-known structured, charge volume and form cumulative charges on defined mechanical characteristic materials.

My research concentrates on tools working with cumulative effect. Its objective consists in modeling the mode of effect by finite element method and intelligent mathematical software, simulation of the process, and comparison of results with practical results.

Creation of the model is the most difficult and most important part of the engineering. A well created model allows simulation of the explosion process which can be well applied in designing firearms, their ammunitions, in development and modernization of existing firearms. Simulation is absolutely necessary for optimization and analysis of the product.

By the help of simulation and analysis we can get preliminary data about reliability under different circumstances. These data can be well applied in designing and testing life-cycles.

According to the designing concepts and objectives, it was necessary to develop such a simulative procedure by the help of which the cumulative effect can be modeled and by the results of it impact of changing certain parameters can be tested and analyzed.

Beyond the design and development, the software system is suitable for training science facilitate check of algorithms and implementation of tools, therefore allows to spare time.

SEARCHING METHODES

In my dissertation I applied both general and extreme searching methods.

In the processing of professional references and publications on internet I used the method of analysis, synthesis, induction and deduction.

It follows from nature of the subject chosen, that processing of the collected professional literature was executed by means of analytical method, and after systematization, available information were synthesized.

Hypothesis were created after getting deep knowledge of the professional literature, and proofing of which was executed in the dissertation.

I created the model of cumulative effect with finite element method. I evaluated the model, made comparison with practical observations, made necessary corrections and refinements.

I participated to several scientific conferences joining to the subject of my dissertation.. My results were regularly published in professional magazines and scientific conferences. (See: list of publications)

SUMMARY OF THE RESEARCH, THESIS

In order to achieve objectives formed in the introduction, I executed the following activities:

In the first chapter I presented the arrangement of the experiments for the cumulative effect and the materials applied. This arrangement follows the basic system of physical FEM modeling, from which I create the discrete model by abstraction of essential characteristics. In this chapter, I resumed most important development steps of the finite element method, and described the software necessary for the creation and solution for the discrete model. Since, in the practical tests, a number of complex physical processes took place, I divided it to several parts.

In the second chapter I modeled the process of the explosion. I created mathematic model of the process by the help of professional literature, and also created the finite element method

with the chosen software. I executed resolution with different dividing precision and also executed computer supported simulations. I compared results with each other and with theoretical ones.

I determined from the analysis of the results, that the chosen software is appropriate for the simulation on computer of the process. By the refinement of the finite element network, theoretical value can be well accessed. Considering the performance of the available computer, I determined the fineness grade of the network, which is necessary for the scientific test, and can be exact enough for the scientific work.

In the third chapter, I examined spreading of the explosive products and impulsive waves depending on the shape. As a result of the simulation made on explosive put into a vacuum space, that the character of the impulsive wave is the same as described in the professional literature.

In the fourth chapter I resumed main characteristics of the cumulative effect, according to the professional literature. I present theories and equations belonging to the cumulative effect. On the basis of this, I created the mathematical model, and presented the evolution of the jet as a result of the finite element model.

In the fifth chapter I described the principle of the armour penetrating, and resumed the experimental formulas. Considering the experimental conditions, I set up the computer model, and compared simulation results with the experimental ones.

PHRASING OF THESIS

According to the all above, results of my research work targeting the development of military tools and systems based on cumulative effect (my thesis) are as follows:

1. I worked out a mathematical model for the examination of cumulative effect, by execution of physical tests. This model can be used for modeling fast processes considering real conditions.

2. I created and programmed parameters in finite element method, which can reduce running time and results remain within the accepted tolerance, therefore they are convenient for other research work.

3. I proved that results and models are in conformity with practical explosive and mechanical tests and results. I proved by tests that the model and the calculation procedure can be applied in the practical design.

RECOMMENDATION OF THE DISSERTATION

In my dissertation I simulated a brisant explosive process and an armour based on cumulative effect. Results help further researches in different directions.

As technical development, more exact results can be reached due to refinement of parameters in programs run on big capacity computers.

New opportunities will be open to know very fast processes and effects and to exploit resources hidden in them up to now.

The software tested is appropriate of the development of existing and new tools. The software allows to optimize developments from point of view costs and time.

Spectacular display of the software allows to use it in the education and in creation of different presentations.

PERSONAL PUBLICATIONS IN THE TOPIC

1. Bugyjás József:: Effects of the modeling results of increasing finite element numbers, Hadmérnök V.évf. 2 .szám pp. 65-72 2010 június ISSN 17885-1919

2. Sipos Jenő - Bugyjás József: A végeselem-módszer kialakulása és katonai műszaki alkalmazása, Bolyai Szemle 2005/2 ISSN:1416-1443

3. Bugyjás József: Számítógépes szimulációval végrehajtott robbanási folyamat modellezése és elemzése, Elektronikai technológia, Mikrotechnika 48.évf. 1-2.sz. pp. 3.-9. HU ISSN 0236-8676 2009

4. Bugyjás József: Quality management recommendations for suppliers to NATO, XXIII. Kandó Conference 2006, Budapest 2006. január 12.-13. ISBN 963 7154 426 (electronic publlication)

5. Bugyjás József: Kumulatív hatású lőszer hatásmechanizmusának vizsgálata „New Challeges in the field of military sciences 2005”, 2005.10.18-19 ISBN 978-963-87706-4-6

6. Bugyjás József: Számítógépes szimulációval végrehajtott robbanási folyamat modellezése és elemzése, XXIV. Nemzetközi Kandó Konferencia, 2008 ISBN 978-963-7154

7. Bugyjás József: A robbanási folyamat modellezésének problémái. „New Challeges in the field of military sciences 2009”, 2009.11.18.-19. ISBN 978-963-87706-4-6

8. Bugyjás József: A kommutatív jelenség modellezése II.. Tudományos Szimpózium 2007 ISBN: 978-963-7154-61-4 (electronic publication)

Professional CV

Personal Data

Name:	**Bugyjás József**
Birth:	Budapest, 22nd, October 1957
Marital status:	married, two children
Residence:	2094 Nagykovácsi, Tompa M. u. 13.
Telefon:	+36 1 666 51 83
e-mail:	bugyjas.jozsef@kvk.obuda-egyetem.hu

Studies:

1972-76	Fazekas Mihály Capital Practical Gymnasium, Mathematical faculty
1977-82	Budapest University of Technology and Economicsm, Faculty of Mechanical Engineering
1985-87	Budapest University of Technology and Economicsm, Faculty of Mechanical Engineering, Precision Mechanics Depatment, second diploma
1994	Participation in Quality training
2004-	ZMNE Military Technical Doctorial School

Languages:

1985	French , medium degree „C”
2007	English, medium degree „C”

PC knowledge:

MS Office: Word, Excell, PowerPoint, Frontpage

AutoCAD

ProDESKTOP 2000i

Patran

Dytran

Jobs

1982-91 Hiradástechnika Szövetkezet,

1983- Development Dept., developing engineer.

1992 Computex Textilipari Műszer- és Számítástechnikai Fejlesztő Vállalat developping engineer

1992-94 MMG AM Rt., developing engineer

1994- Kandó Kálmán Technical College, (from 2000 Budapesti Polytechnic, from 2010 Obuda Uneversity), Institute of Microelectronics and Technology

Senior lecturer, from 2006 master teacher

Tárgyfelelős: General Engineering Knowledge
Rendszertechnika

1996- Deputy Director

1997-1999 Member of the Committee of Supply of College

2002 *Member of the Organasitain committee of* Kandó Conference 2002 International Scientist session

2004- ***ZMNE Student of Katonai Műszaki Doktori Iskola***

2006 Member of Kandó Conference Committee 2006

2008 Member of Organizing Committee for XXV. Kandó Conference

2009 Member of Organizing Committee for XXV. Kandó Conference, section president

2010 Member of Organizing Committee for XXV. Kandó Conference

Main Activities:

1979-82 Participation in Scientific Students Association

Main Areas:

- evaluation of multispectral air-photos
- elaboration of black-and-white (pseudo-coloured) photo-procedure
- design of specrto-photometer

1982-91 Main development areas:

- New type of "school-computer" mechanics of peripheral units for new type of „school-computer"
- Development, installation and putting into operation of photo-processing system "Atlasz"
- Design of High-precision coordinate-table, elaboration of underside and overside lighting system,

1992 - modernization of existing textile installations, elaboration of new textile balance

1992-94 - Design New levelers

1994-

Educational activity:

- General engineering Information – practice and lecture
- Knowledge of CAD– practice,
- Technology – practice,
- Quality assurance – practice,
- Technical documentation,
- System engineering - lecture, practice,
- Fundamentals of Security, protection of the environment, and Quality assurance – lecture
- Mathematics - practice

Participation in applications:

TEMPUS S-JEP 09631-95

FEFA IV/a. project number:1511

FP 32/98 "Minőségügyi oktatók szakmai továbbképzése"

Grands:

1998 One month on University of Abertay Dundee

2004 Furtwangen

2006 Nürnberg

Awards:

1980 BME Science Conference for students, 1st award

1985 International Fair of Budapest, Creative Youth, 1st award

1999 An accomplished teacher of Kando

2000 Mention by Dean

2005 Mention by Dean

Numerical Data for Scientific Activity:

TDK paper: 1; Professional publications: 5; Presentations: 3; Studies: 1;