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WAVES IN THERMOELASTIC AND PLASTIC SOLIDS
Revising Old Problems by New Solutions

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Abstract

In 1973 there was the Bulgarian 2nd National Congress of Theoretical and Applied Mechanics. The program contained several dynamical problems. Let us recall two of them dealing with the shock waves in thermoelastic solids [1] and with the constitutive equation of the dynamic, plastic tension [2]. The reason of the choice is very simple. The author met, got aquainted and became friend with Juri Engelbrecht there and then.

Recalling the papers one can see that the problems are still vivid even several dozen of papers have dealt with the tasks meanwhile, the results have been used in different fields of natural sciences and in engineering. The basic difference is not in the purpose, but in the methods used to obtain the solutions.

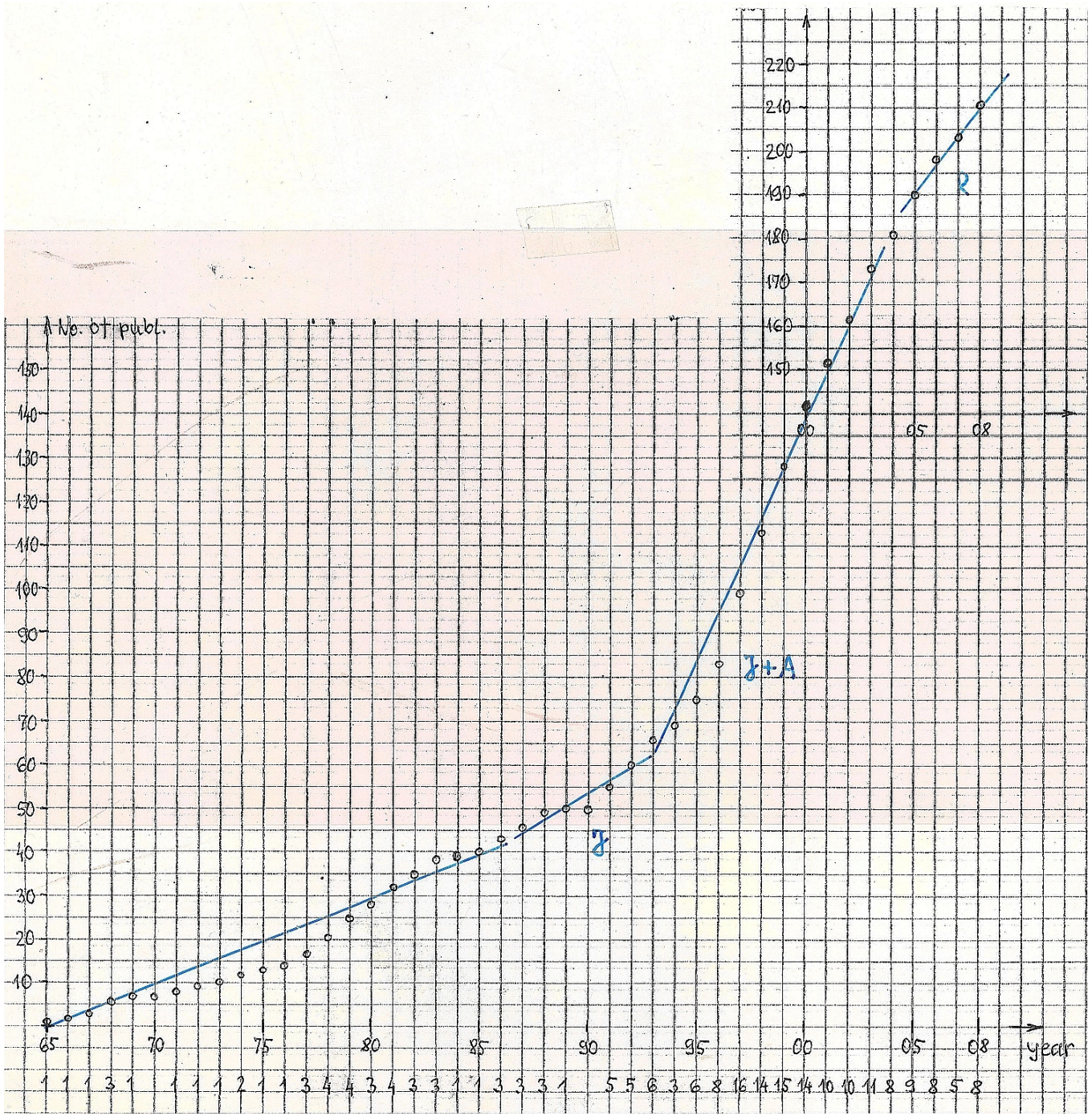
In this paper our goal is to analyse the new technics, e.g. the numerical calculations, mainly the FEM and the possibility of the electrical analogy (EA) emphasizing the difference between them.

Now-a-days the role and importance of FEM and other numerical methods is clear, it is not needed to underline. The benefit of the EA is far not as trivial, even though there are several applications, e.g. [3].

In our paper we deal with the advantages given by the EA. By a comparison between EA and FEM we try to separate the really useful and less useful parts of the EA. Finally, we attempt to generalize the problem concerning the proper attitude towards the old and the new methods.

References

1. Engelbrecht J: Creation of Shock Waves in Thermoelastic Solid. Pres. held at 2nd National Congress of Theoretical and Applied Mechanics (2nd NCTAM), Varna, 8-14 Oct, 1973, Bulgaria.
2. Beda Gy, Szekeres A: Analysis of a Possible Constitutive Equation of the Dynamic Plastic Tension. Pres. held at 2nd NCTAM, Varna, 8-14 Oct, 1973, Bulgaria.
3. Szekeres A: Coupled Fields and Electriacal Analogies of Mechanics. Pres. held at 25th Midwestern Mechanics Conference. Sept 21-24, 1997, South Dakota School of Mining and Technology, Rapid City, SD.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THE STORY OF OUR FRIENDSHIP

- 1973 Varna

– 1987 Tallinn, CSc

– 1996 Budapest, honorary member of HAS

– 1998 Budapest, honorary doctor of TUB

– common publications: papers and lectures

– common conferences: FUDoM 95, 98, 01, 05, 09

– visits in Budapest 10-12 times, in Tallinn 25-30 times

SECOND NATIONAL CONGRESS OF THEORETICAL AND APPLIED MECHANICS

VARNA, 8—14 OCTOBER, 1973, BULGARIA

PROGRAMME

BULGARIAN ACADEMY OF SCIENCES

NATIONAL COMMITTEE OF THEORETICAL AND APPLIED MECHANICS

SECTION I
MECHANICS OF CONTINUUM MEDIA

THUESDAY, OCTOBER 9 1973

Morning session

ROOM 1

Chairman: G. Brankov, Prof.

8.30— 8.50 **Bowen R. M. and Chen P. I. (USA)**
Shock Wave Propagation in a Mixture of Diffusing Gases

8.50— 9.10 **Brankov G., A. Rachev, Ts. P. Ivanov (Bulgaria)**
On the Thermodiffusion in Micropolar Solid

9.10— 9.30 **Engelbrecht I. K. (U.S.S.R.)**
Creation of Shock Waves in Thermoelastic Solid

9.30— 9.50 **Chen P. I. (USA)**
Waves in Laminated Composites-Theory and Experiments

9.50—10.10 **Ivanov Ts. P., A. Rachev (Bulgaria)**
Thermoelastic Waves in a Prestressed Circular Cylinder

Afternoon session

ROOM 4

Chairman: P. Marinov, Assist. Prof.

14.30—14.50 **Brankov G. and N. Petrov (Bulgaria)**
On the Linear Electroviscoelastisity

14.50—15.10 **Belubekian M. B. (U.S.S.R.)**
Magnitoelastic Vibrations of TWO Parallel Conducting Plates

15.10—15.30 **Stefaniak J. (Poland)**
Plane Source of Distortion in a Constant Magnetic Field Existing

16.10—16.30 **Viznyuk G. I. Molchanov I. N. Zamula G. N. (U.S.S.R)**
Some Speede Convergent Iterative Methods for solution of Difference Equations, Describing The Stress-Strain State of Cylindrical Shells

Pause

Chairman A. Petrova-Deneva, Assist. Prof.

16.50—17.10 **Tepavicharov A. D. (Bulgaria)**
On the Statical Investigation of Oblique Hyperbolic Parabolic Shells $Z=c\,x\,y$ on Rectangular Base

17.10—17.30 **Nikolaev N (Bulgaria)**
A Stressed and Deformated State around Circular Hole in Elastic-Viscous continium Loaded with Nonregular Pressure

17.30—17.50 **Kishkilov M. M. (Bulgaria)**
Axisymetric Bending for Creep of Round Glass-reinforsed Plate

17.50—18.10 **Kishkilov M. M. Khristov H. T. (Bulgaria)**
Non-axisymetric Bending of Round Plate for Creep Conditions

SUBSECTION 2

ROOM 5

Chairman: A. Baltov, Assist. Prof.

10.15—10.35 **Baltov A. Vodenicharov S. (Bulgaria)**
Investigation of Deformation Anisotropy for Viskoplastic Deformation of Metals

10.35—10.55 **Beda Gy. Szekeres A. (Hungary)**
Analysis of a Possible Constitutive Equation of the Dynamic Plastic Tension

10.55—11.15 **Maier G. Corradi L. (Italy)**
Upper Bounds on Dynamic Deformations of Elastic. Workhardening Contunua with Piecewiselinear Yield Surfaces

11.15—11.35 **Kosachevskaya E. A. Kosachevskiy L. Y. Strochkov I. A. Gvozd V. I. (U.S.S.R)**
Axisymetric Flow of Plastic Material in Curvilinear Injection Mould

SECOND NATIONAL CONGRESS OF THEORETICAL AND APPLIED MECHANICS

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ABSTRACTS

BULGARIAN ACADEMY OF SCIENCES

NATIONAL COMMITTEE OF THEORETICAL AND APPLIED MECHANICS

BÉDA GY., A.SZEKERES - HUNGARY

ANALYSIS OF A POSSIBLE CONSTITUTIVE EQUATION OF THE DYNAMIC PLASTIC TENSION

The third equation of the partial differential equation system:

$$\rho v_t = \sigma_x ; \qquad v_x = \varepsilon_t ; \qquad \Phi(\ldots) = 0$$

which describes the problem of the dynamic plastic tension of a prismatic par, is the constitutive equation. A possible form of this equation is

$$\sigma_t = \Phi(\sigma, \varepsilon, \varepsilon_t, \varepsilon_x)$$

In order to check up the detailed construction of this constitutive equation, we elaborated a solving method of the system (1) and made numerical examples.

BLANC R.H. - FRANCE

PROGRESS IN PULSE TESTING METHODS FOR VISCOELASTIC SOLIDS

It is proposed to determine the dynamic characteristics of linear viscoelastic media using a transitory excitation method. This consists of observing the puls $f(x,t)$, propagated in a bar of the material studied after producing an axial shock at one end.

Three theories are proposed for deducing the phase velocity $c(\omega)$ and attenuation coefficient $\alpha(\omega)$ of the plane longitudinal waves in the material from the change in pulse-shape through the bar. The first theory is based on simplifying assumptions concerning the shape of the initial impulse and the functions $c(\omega)$ and $\alpha(\omega)$ obtained directly from the recordings of $f(x,t)$; this is an approximate, rapid method. The other direct method deals with the response of a selective frequency filter to the transient signal $f(x,t)$; this method gives precise attenuation measurements. The third method provides the general solution of the

ФИЛАТОВ А.Н. - СССР

ИССЛЕДОВАНИЕ ДИНАМИЧЕСКИХ И КВАЗИСТАТИЧЕСКИХ ЗАДАЧ ТЕОРИИ ВЯЗКО-УПРУГОСТИ С ПОМОЩЬЮ МЕТОДОВ УСРЕДНЕНИЯ

Известно, что динамические и квазистатические задачи теории вязко-упругости сводятся к исследованию интегро-дифференциальных и интегральных уравнений различных классов. Для исследования таких уравнений предлагаются различные методы усреднения. Например, решения системы нелинейных интегро-дифференциальных уравнений вида

$$\dot{x} = \varepsilon X\left(t, x, \int_0^t \varphi(t, s, x(s))\, ds\right)$$

аппроксимируются решениями усредненной системы дифференциальных уравнений (1-3)

$$\dot{\xi} = \varepsilon X_0(\xi)$$

где

$$X_0(x) = \lim_{T\to\infty} \frac{1}{T} \int_0^T X\left(t, x, \int_0^t \varphi(t, s, x)\, ds\right) dt$$

Установлена близость решения систем (I) и (2) как на конечном, так и бесконечном промежутке. Показано, как уравнения теории вязко-упругости могут быть сведены к исследованию уравнений типа (I).

Приведены решения конкретных задач теории вязко-упругости методами усреднения.

ЭНГЕЛЬБРЕХТ Ю.К. - СССР

ВОЗНИКНОВЕНИЕ УДАРНЫХ ВОЛН В ТЕРМОУПРУГОЙ СРЕДЕ

Рассмотрен одномерный переходный процесс распространения упругих волн в термоупругой среде, математическая модель которой построена на основе физически и геометрически нелинейной теории термоупругости с учетом конечной скорости распространения тепловых возмущений. Показано, что в случае возбуждения механического характера в среде может образоваться

ударная волна в виде т.н. ударного профиля, который представляет собой непрерывное решение модельного уравнения. Установлены условия и асимптотическая оценка времени воникновения ударного профиля. Показано различие между математическими моделями, построенными на основе теорий упругости и термоупругости, а также между моделями, учитывающими бесконечную и конечную скорость распространения тепла. Указаны другие модели диссипативных сред, приводящие к этому же модельному уравнению. Приведены примеры анализа для конкретных краевых условий.

ELECTRICAL ANALOGY (EA) OR NUMERICAL CALCULATIONS (EG. FEM)?

(Thoughts on a special opinion)

A few years ago in connection to my idea ”EA in Bio-Thermo-Hygro-Mechanics” the following opinion came up: ”Now-a-days no importance of the EA, the numerical calculation has replaced it. The physical experiments yes, but no EA.”

It reminds me on two cases, that happened 10-12 and 5-6 years ago. 1. I met somebody who was the member of the IUTAM Congress Programme Committee and worked carefully on his proposal. I asked him about the importance of such a work and his opinion was very interesting: ”Yes, it is important because we have to be very careful, otherwise in the near future all presentations will be on FEM.” I agreed. 2. A few years later I recalled his above mentioned opinion in connection to the composites. ”If we are not careful enough, half of the presentations will be on FEM and the other half on the composites.” He agreed.

There are several signs that our fear (of such kind of problem) had real roots. Now the question is, why he has changed his opinion, why he thinks that the EA can be dropped and replaced by FEM or any other numerical method? There is another question too, whether this problem could be generalized and all the classical methods can be dropped and replaced by the advantage of the computers?

My opinion is very cautious. Let me tell you two examples, one for yes, one for no! 1. No doubt, the time of the graphical methods in mechanics is over, nobody would solve any problem of the statics now-a-days by ruler! OK, let’s drop the old methods, vivat PC!

2. 35 years ago I applied for some financial support for a topic on ”solving problems of mechanics by digital computers”. (Now-a-days such a proposal is called project proposal.) It was refused and the explanation was very simple, ie. there is the mechanics and there is the digital computer, but there is no relation between them. I think no comment is needed!

The summary of all mentioned above, at least according to my taste, is the following: always hesitate to drop the old, but never hesitate to accept the new! It is still open the original opinion completed with the question how general is this opinion among the the researchers! Let’s put an imaginary question and imagine the possible answers!

Concerning the generalization of the problem, ie. what to drop and what to keep, I have some comment. The motto could be Lanczos’ consideration on the sum of the degrees of a triangle. It emphasizes the importance of the theory in making experiments.

Eg. the application of the EA gives triple-fold advantages. First one is the experimental possibility. OK, let us drop it, because it can be replaced by numerical calculations. Second, the analytical results obtained in electrotechnics can be generalized for our problems, eg. BTHM. After some hesitation we may drop it, because we already have got the numerical results, we don’t need the analytical ones. Third, the theoretical possibility, that gives a deeper insight into the BTHM phenomena. And it can’t be replaced by any other tool. No doubt, the theory is needed, not only because for itself, but also because of the experiments. If the experiment has no theoretical background, it is impossible the proper evalution of the results. As an example see Einstein’s joke on the flea’s leg and ear!