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# CONSIDERATIONS REGARDING FINITE ELEMENT MODELLING OF A PIEZOCERAMIC TRANSDUCER – PART II–

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Key words: piezoceramic transducer, ultrasounds, finite element, ANSYS

Summary: The paper describes the finite element modelling of an ultrasonic piezoceramic transducer, which represents the active element of an ultrasonic system – the component part of an ultrasound processing plant.

## 3. GENERAL NOTIONS REGARDING FINITE ELEMENT MODELLING

When considered altogether, all elements of the acoustic system should be, for whatever use, precisely calculated, designed and executed in a perfect coordination of the acoustic, mechanical and constructive parameters.

The calculation and dimensioning of the system is made so as to operate under resonance regime taking into account all technological processing parameters; that is why the ultrasonic system modelling represents a very demanding issue, although necessary at the same time. Subsequent to the analysis of different modelling methods, scientists have reached the conclusion that modelling through finite element method using the ANSYS package is the most recommended.

The ANSYS package has been created as an engineering tool which allows the creation of some complex mathematical models for almost all interest domains of engineering sciences.

The ANSYS package modules allows the implementation of some finite element tests, from the easy ones such as linear, static, to the complex ones, non-linear, dynamic and transient.

This calculation instrument proves the more valuable as the researcher wants to perceive the behaviour of some systems evolving at high frequencies (for instance frequencies corresponding to the acoustic domain).

The first step to be taken within the modelling process is the object geometrical construction. For the practical case of an acoustic system intended for surfaces finishing conditioning, the geometry is elaborated by means of CAD specialized programs which are compatible with ANSYS. The achieved geometric model by using a CAD program is exported in a format recognizable by the finite element analysis program.

## 4. FINITE ELEMENT MODELLING OF ULTRASONIC TRANSDUCER

The geometrical dimensions of an acoustic energy transducer employed within an acoustic processing plant, are given in figure no. 4.

Finite element modelling of acoustic energy transducer, using the ANSYS program, supposes covering the following stages:

In the first stage, one departs from the geometrical dimensions of acoustic energy transducer, resulted from the calculation procedure and rectified due to resonance considerations.

In the second stage, the main properties of materials from which the acoustic energy transducer is being manufactured are being introduced. The radiant element is made up of aluminum, the reflector element of carbon steel, and small piezoceramic plates are being used as active elements (PZT 4).

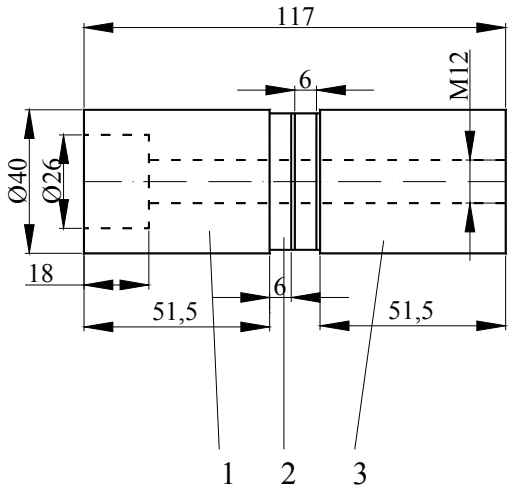


*Fig. 4 Geometrical dimensions of acoustic energy transducer employed in an ultrasound processing plant*
*1 - reflector element; 2 - active element; 3 - radiant element.*

In the third stage, the type of structural analysis is being selected from the main domain; the analysis also conditions our resorting to libraries with digitization elements.

The fourth stage implies the selection of the digitization element from the ANSYS library. The digitization element SOLID 92 is selected within the ANSYS library SOLID 92 3-D 10-Node Tetrahedral Structural Solid is an element displayed in figure 5.

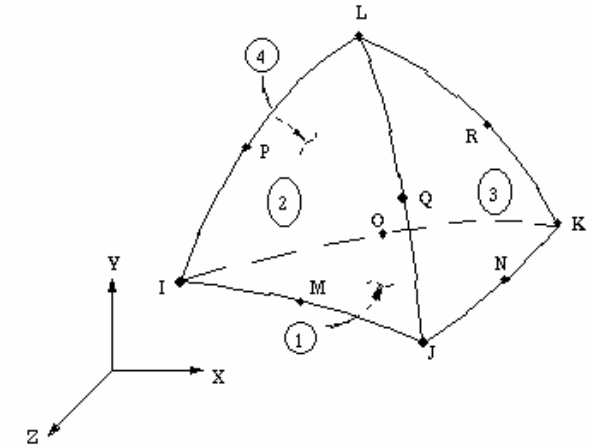


*Fig. 5 The shape of digitization element SOLID 92 3-D 10-Node Tetrahedral Structural Solid*

In the fifth stage, the PREPROCESSOR is being activated from the main menu where the geometry of the volume represented in figure 6 is being generated.

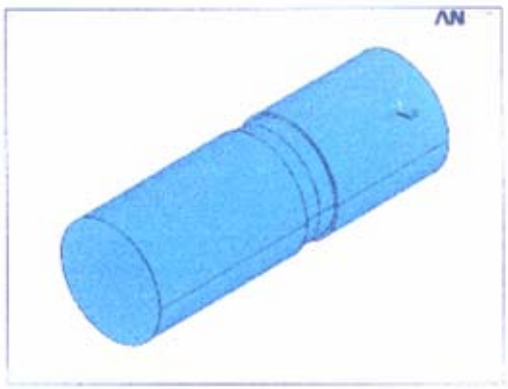

*Fig. 6 Generation of volumes geometry for the piezoceramic ensemble*

In the sixth stage the digitization element and the dimension of the meshing element are being selected. Digitization by means of SOLID 92 element of this volume generates 11356 elements with 18465 nodes, as it is shown in figure 7.

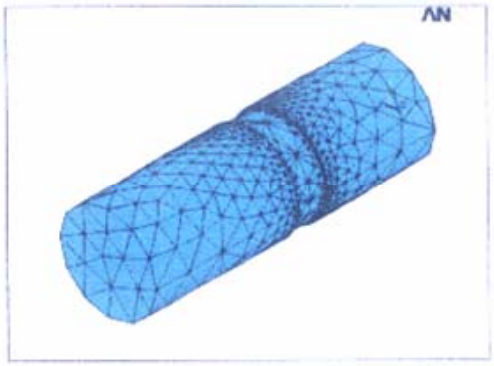

*Fig. 7 Volume digitization by means of digitization element SOLID 92*

In the seventh stage, after the activation of "SOLUTION" processor, the harmonic type of analysis is then adopted.

In the eighth stage, complying with physical reality, the power source (acoustic sound generator) carries electrical loads on the electrodes conventionally located on the polarization direction of piezoceramic chips, the necessary frequency to enter a resonance regime of the piezoceramic ensemble.

The figure no. 8 represents the symbols corresponding to electrical loads applied on the nodes located in surfaces on which electrodes are placed, whose values are comprised within the tolerated interval (0 ÷ 800V).

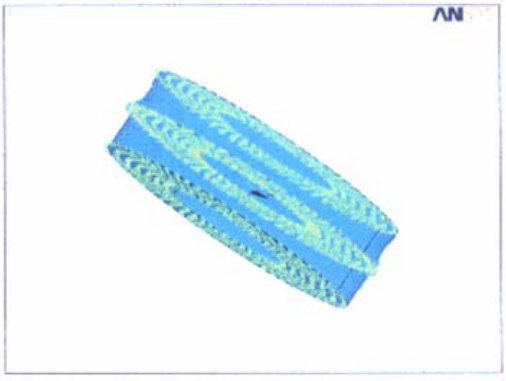

*Fig. 8 The application of voltage loads*

The states distorted and undistorted of the piezoceramic transducer represented by the graphical interface settings in isometrics and frontal settings are given in figure 9 and figure 10.

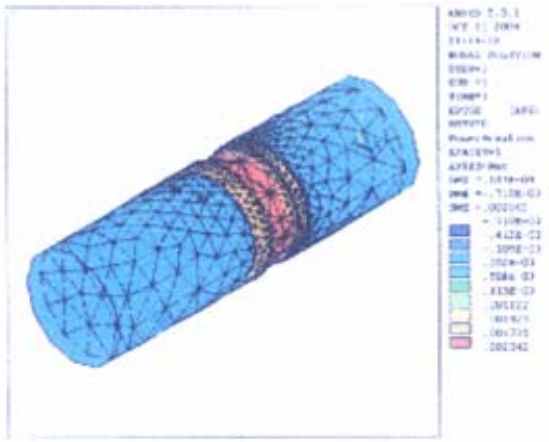

*Fig. 9 Isometric representation of distorted / undistorted of piezoceramic transducer*

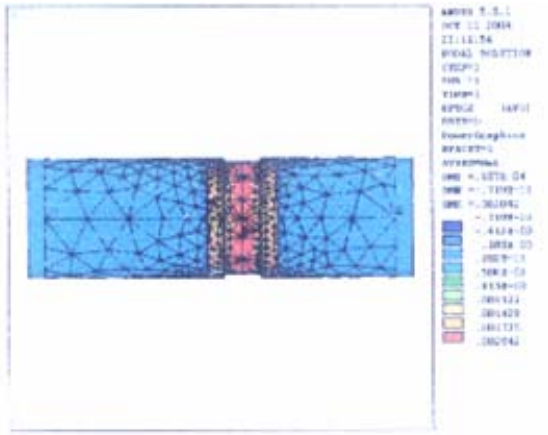

*Fig. 10 Frontal representation of distorted / undistorted of piezoceramic transducer*

## 5. CONCLUSIONS:

The advantage of modeling by means of finite element method relieves the researcher from the performance of an experimental laborious program necessary for a statistical model which shall represent in a satisfactory manner the genuine studied phenomenon. In this sense, only a single entry data is supposed to be necessary processed from reality through measurements. Moreover, a result obtained from an analysis is adequate as an initial value for further analyses.

The calculation and dimensioning of the system is made so as to operate under resonance regime taking into account all technological processing parameters; that is why the ultrasonic system modelling represents a very demanding issue, although necessary at the same time. Subsequent to the analysis of different modelling methods, scientists have reached the conclusion that modelling through finite element method using the ANSYS package is the most recommended.

## 6. BIBLIOGRAPHY:

[1] Amza, Gh., Ultrasunetele – aplicații active – Editura AGIR, Bucureşti, 2006;
[2] E., Bădărău, ş.a., Ultraacustica fizică şi tehnică, Editura Tehnică, Bucureşti, 1967;
[3] Chirculescu, G., Utilizarea ultrasunetelor în creşterea calității suprafețelor prelucrate prin aşchiere, referat nr. 2;
[4] Constantinescu, I., Sorohan, Şt., Practica modelării şi analizei cu elemente finite, Bucureşti, 2002.