ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA

2004, Tome II, Fascicole 1

THEORETICAL RESEARCHES REGARDING THE DETERMINATION OF THE STRESSES WHICH APPEAR IN THE NOZZLES OF THE PEST AND DISEASES CONTROL THROUGH CHEMICAL MACHINERY USING COMPUTER PROGRAMME "COSMOS/M" WITH FINIT ELEMENT

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Abstract:

In speciality reference material from our country and in the countries with an advanced agriculture it hasn't appeared yet a calculation methodology with a view to projection's optimisation of these nozzles and on this line, the current paper, tries to bring a contribution in this field, benefiting by the advantages on which it presents the application of the analysis method with finite elements respectable programme of computer "COSMOS/M".

By means of "Finite Elements Method" (FEM) respectively of "COSMOS/M" programme it could be performed the stress state,s modelling in the nozzles, finally the author achieving one subprogramme of calculus. On the basis of this subprogramme, a complete study of the stress state was effected, using the "Finite Elements Method" (FEM).

Following the analysis with finite elements were calculated all the component parts of the stess tensor from the network's knots, as well as, from the centre of each finite element, for one working regime.

Keywords:

nozzle, Finite Elements Method, strength, stress, digitisation, the 5th theory of strength, COSMOS/M

1. INTRODUCTION

The methods of pest and diseases control of the agricultural crops through chemical way, by sprinkling, hold the biggest weight from the methods applied and utilized in crops protection.

It is estimated that the application of this method represents about 75% from the altogether of the ways and methods of control with pesticides in agriculture.

The application of the liquid pesticides by sprinkling it is achieved under the aspect of a very fine film or under the aspect of some extreme small drops. The fineness of the dispersion it is estimated by the size of the particles' (drops') diameter. The uniformity constitutes a distinct specific feature, considering that a dispersion is all the more uniform as the quantity of the particles with the same diameter is bigger.

The spraying of the solid chemical substances it is achieved by means of the nozzles. For the achievement of a suitable spraying of the chemical substances and implicitly of a quality uniformity of these it is imperious necessary that the nozzles to have a long tiredness in time. Also, the nozzles must be strength at the chemical action of the utilized substances at the pest and diseases control in agriculture.

Therefore, the study of the strength state out of the nuzzle represents a very important present problem, which leads to the achievement of some nozzles which resist in time at both tiredness and chemical action of the sprinkled substances.

2. THE MODELLING OF THE STRESS STATE FOR HARDY NOZZLE, USING THE PROGRAMME WITH FINIT ELEMENT "COSMOS/M"

Within the framework of the Strength of Materials Department from the Technical University Timişoara was studied the Hardy nozzles (figure 1), utilized at the sprinkling of the crops. The study followed the determination of the maximum stress zones, where can appear fissures or even tears during the working process, using the Finit Element Method and respectively the "COSMOS/M" programme. For the calculus of the strength state out of the Hardy nozzle it was achieved a calculus subprogramme.

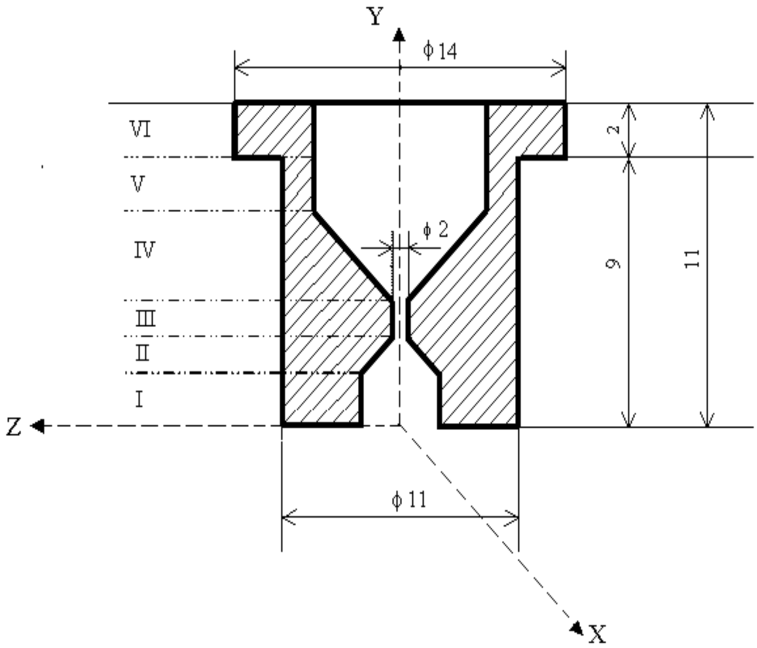

Fig. 1. *Section through the studied Hardy nozzle.*

In order to achieve moulding as good as possible the nozzle was divided in six zones, conveniently selected.

The calculus was done for the most unpropitious case of loading that is when the sprinkling solution passes through the interior of the nozzle with a maximum pressure of 6 bar. This pressure was applied on the internal walls of the nozzle.

The digitisation of the nozzle it was done using isoparameter elements of thin plate type, with four knots on element and eight degrees of freedom on knots (figure 2). The net of finit elements used it was achieved by variable step, with a denser net in zones of passing from a larger diameter to a smaller diameter of the nozzle. For the knots in the fastening zone of the nozzle in the body of the nozzle and implicitly on the platform of the sprinkling machine were introduced bottomings for all those eight degrees of freedom.

In the fastening points were considered hampered the changes of place and turnings in all directions (ox, oy, oz) considering these points as being embedding points.

We introduced as well as real constants, associate to the selected elements group, the thickness of the nozzle, Poisson's ratio (for polyethylene ν = 0,26) and as well as material properties, the longitudinal resilience modulus(E = 14•10^3 MPa) and transversal resilience modulus.

There were determined σ_x, σ_y, σ_z and τ_{xy} stresses specific to the plane state of deformation, σ_1, σ_2 and σ_3 main stresses, as well as the equivalent stress in accordance to the 5th theory of strength (Von Mises), which it is calculated with the relation:

$$\sigma_{ech.} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1\sigma_2 - \sigma_2\sigma_3 - \sigma_3\sigma_1} \qquad (1)$$

The stress state was also completed with a calculus of the change of place.

Figure 2 presents a sample of the obtained by using the achieved subprogramme and figure 3, 4, 5, represent the mode of accordance to the 5th theory of strength (Von Mises) in the case of Hardy nozzle.

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TITLE : THE UTILIZATION OF THE “COSMOS/M” COMPUTER PROGRAMME AT THE DETERMINATION OF THE
STRESSES WHICH APPEAR IN THE NOZZLES FROM THE MACHINERY OF PEST AND DISEASES CONTROL THROUGH
CHEMICAL WAY IN THE EXPLOITATION PROCESS FROM AGRICULTURE

T O T A L   S Y S T E M   D A T A
NUMBER OF EQUATIONS . . . . . . . . . . . . . . .(NEQ)  =     3240
NUMBER OF MATRIX ELEMENTS . . . . . . . . . . . .(NWK)  =   860508
MAXIMUM HALF BANDWIDTH . . . . . . . . . . . . . (MK )  =     1536
MEAN HALF BANDWIDTH . . . . . . . . . . . . . . .(MM )  =      265
NUMBER OF ELEMENTS. . . . . . . . . . . . . . . .(NUME) =      760
NUMBER OF NODAL POINTS. . . . . . . . . . . . . .(NUMNP)=     1140
SIZE OF EACH BLOCK. . . . . . . . . . . . . . . .(MTBLK)=     8000
NUMBER OF BLOCKS. . . . . . . . . . . . . . . .  (NBLK) =      113
MAXIMUM DIAGONAL STIFFNESS MATRIX VALUE =   .476175E+04
MINIMUM DIAGONAL STIFFNESS MATRIX VALUE =   .274825E+03

S T R E S S   E V A L U A T I O N   F O R   S T A T I C   A N A L Y S I S

  STRESS OUTPUT FOR 3/D ELEMENT GROUP   1      CASE  NO.     1

 ELEMENT    OUTPUT
  NUMBER    NODE  SIGMA-X1  SIGMA-X2  SIGMA-X3   TAU-X12   TAU-X23   TAU-X13  VON MISES STRESS
      1
        CENTER    2.5000E-01 -2.6691E-03 -3.1385E-01 -3.5388E-03 -2.2014E-02 -9.3923E-02
5.1696E-01
             1    4.2813E-01  5.2146E-02 -3.0567E-01 -3.5020E-03 -2.1975E-02 -1.2204E-01
6.7090E-01
             2    4.7723E-01  5.2146E-02 -3.1211E-01 -3.5020E-03 -2.1975E-02 -1.3129E-01
7.2209E-01
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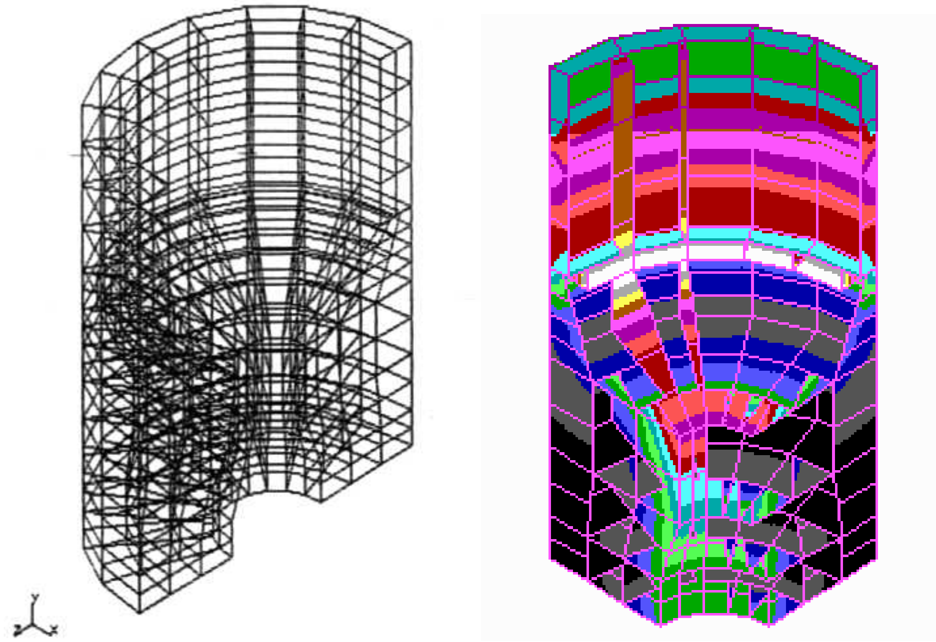
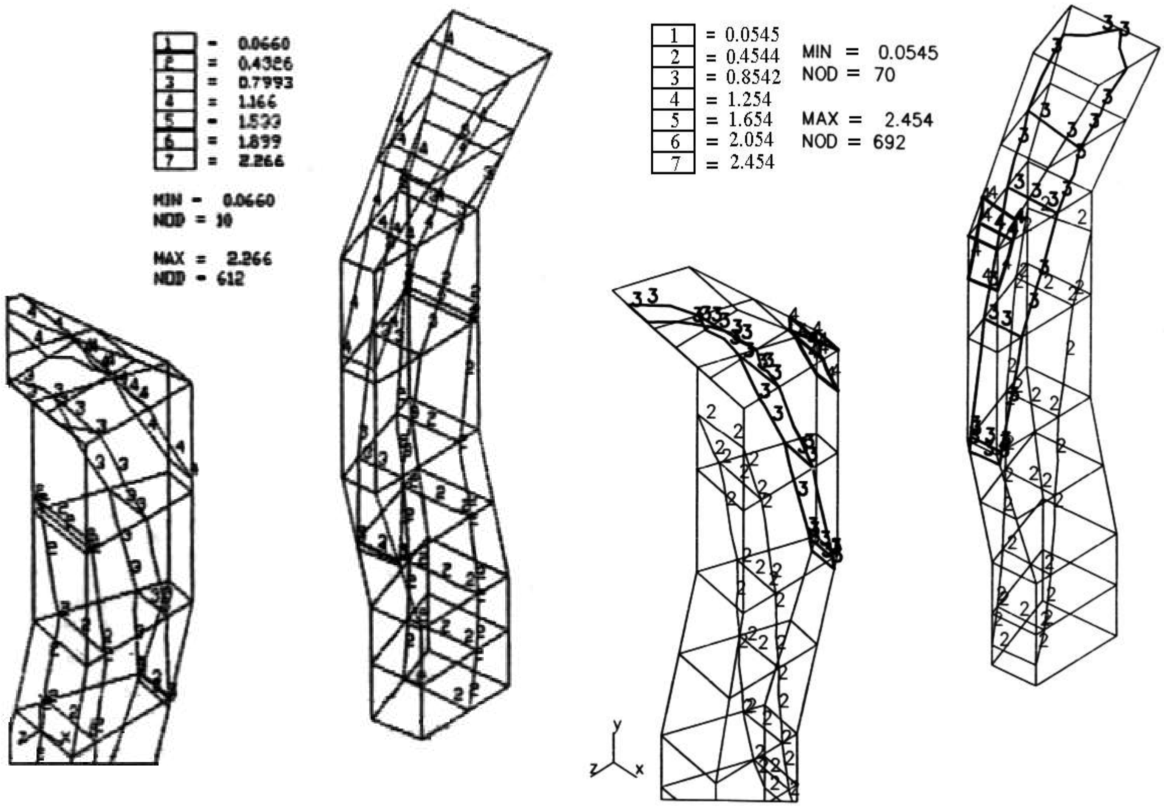
Fig. 2. *Sample with the obtained results.*



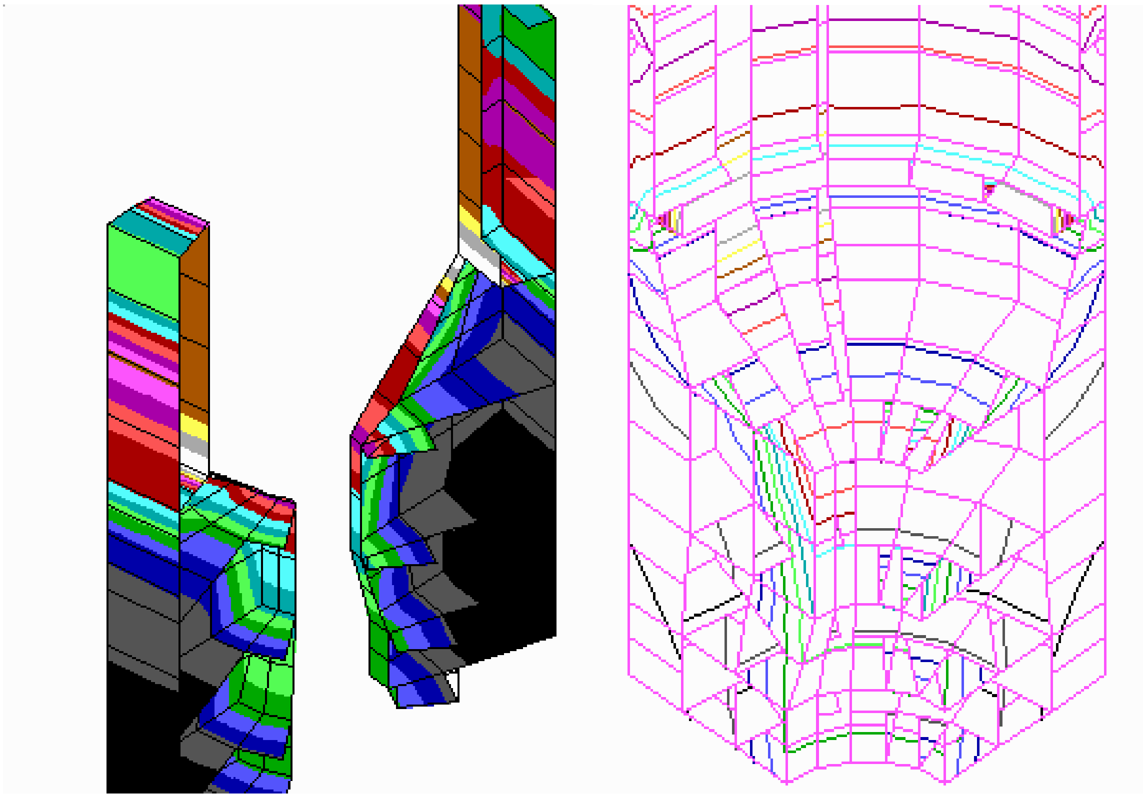
a) b)

Fig. 3. *a) The digitisation model of the Hardy nozzle; b) The distribution of the stresses in accordance to the 5th theory of strength (Von Mises) $\sigma_{ech(5)}$ for sectioned Hardy nozzle, established for the maximum pressure p = 6 bar.*



a) b)

Fig. 4. *a) The distribution of the stress $\sigma_{ech.(5)}$ in the concentration zones of the stresses, in the section 1, for a maximum pressure p = 6 bar; b) The distribution of the stress $\sigma_{ech(5)}$ in the concentration zones of the stresses, in the section 2, for a maximum pressure p = 6 bar.*



a) b)

Fig.5. *a) The distribution of the stress in accordance to the 5^{th} theory of strength (Von Mises) $\sigma_{ech(5)}$, in a section of the nozzle, for the maximum pressure p = 6 bar; b) The distribution of the stress $\sigma_{ech(5)}$ for sectioned Hardy nozzle, in the zone in which it is actual achieved the spraying of the liquid, for a maximum pressure of 6 bar.*

3. CONCLUSIONS

1. The stage of the current development of the scientific and technical level permits the utilization of the Finit Element Method as a fundamental theoretical method of the determination of stresses distribution in the nozzles from the machinery of pest and diseases control through chemical way.
2. In the context of potential's capitalization offered by the COSMOS/M programme in this field, the modelling of the stresses field became a certainty.
3. The theoretical cognition of the stresses distribution is of an unchallenged utility in the evolution's estimate of this process, experimental praised in the ground.
4. The study effected on the Hardy nozzle praised the fact that this is solicited at tiredness in time, because of the pressure which acts on its internal walls.
5. The biggest strengths are manifest in the zones in which the internal diameter of the nozzle is reduced (the zones of influence from a bigger diameter to a smaller diameter), fact that leads to the conclusion these zones are considered concentrators of strength.
6. In order to learn some pertinent conclusions as concerns the determination of the strength at the nozzles of the sprinkled machinery is imperious necessary to be studied as many types of such nozzles as possible, because at present there is a very varied range in the world, and the materials are more and more performant (ceramics materials, composite materials).

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