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STRESS DEPENDENT ROTATED MAGNETIC FIELD BHN MEASURING

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Abstract

The basic Barkhausen-noise (BHN) measuring techniques are well known by the physical sciences. There are various BHN measuring techniques which are applied in industrial field and we would like to introduce another field of application which can be useful and developable. The basic structure of this techniques is that the usually applied BHN measuring method. The difference from the other techniques that we created a totally direction dependent stress control system, and we can change the physical stresses in different directions or combine them. Using the BHN measuring techniques by a rotating measurement – which means that we rotate the measuring head in 10° steps – we can measure the stress changing and the remaining stress in the material. Using this method we can compare the measured stresses with those stress distribution that was calculated by Finite Element Method systems. Besides we can use the measured data to the reverse engineering or as input in the deep drawing tool designing or redesigning procedure. Method could be "circle of deep drawing tool design" could be more efficient and using the accurate data from the BHN measuring – later it can built a database for similar applications – the designing process will be more productive.

I. BHN Stress measuring

Applying the BHN measure method we can measure the remaining stresses (RMS) in different directions. During deep drawing process there are identified areas (by FEM calculations) which contain high amount of remaining stresses. Measuring of these stresses are not properly solved. There are different practical ways to estimate these stresses, but these data are not accurate enough. Applying the BHN technique combined with our newly developed system which can indicate controlled stress conditions we can use the same techniques during the forming process. Equipment shown on the Figure 1.

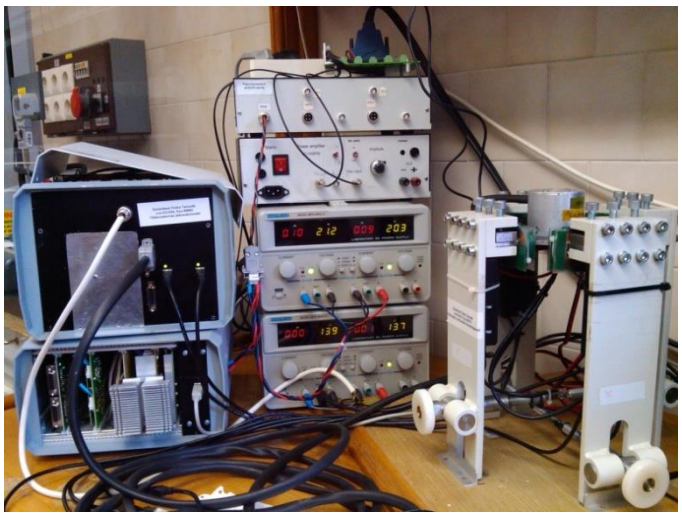

Figure 1. BHN combined with controlled stress

The next step was the solving of the rotation of the BHN measuring head to create the complete remaining stress (RMS) curve of the zone. When we were developed a new type of measuring head to rotate the magnetic field without any movement of the head. This new technique is more accurate than we rotating the head by hand in different degree. Different degrees measuring head is show on Figure 2.

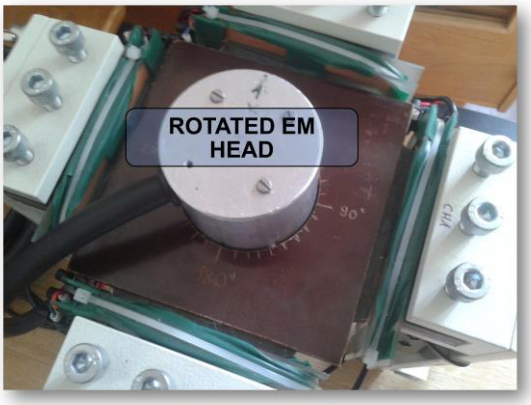

Figure 2. Rotated EM head

II. Measuring software

As my previous publications [1] I discussed, we created the measuring head and we have the method how to measure the RMS in different formed zones, and rotate the magnetic field by software, ee need to create a measuring software which handles the data and all the input to get the most accurate results. The basic requirements of the software:

1. Dynamic instrument control and signal display
2. Automated measurement sequences
3. Data storage, presentation
4. Noise measure evaluation and comparison

II.1. Dynamic instrument control

We built a hardware from different modules which handle different tasks eg. combining the data and control the data inputs for different tasks eg. bending moment of the sheet metal specimen, amplified noise handling, air gap, and voltage and sign control.

II.2. Automated measurement sequences

Measuring and combining different parameters needs various and parallel controlled measuring methods. To control these tasks we have to create different automated sequences to get the best results. The control panel for this process can be seen on Figure 3.

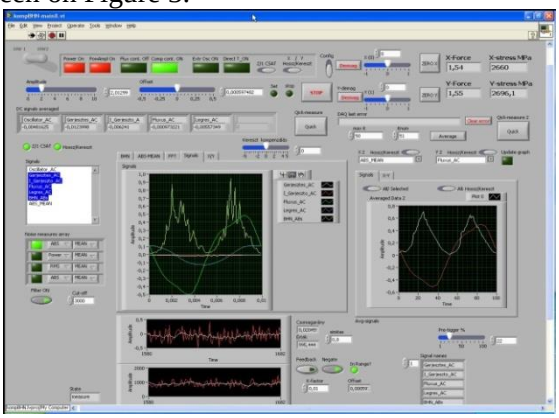

Figure 3. Control panel

II.3. Data storage, presentation

For the future if we measured with combined process we have to handle and save these data to the future use. We also made a data handler part. This part of the software can seen in Figure 4.

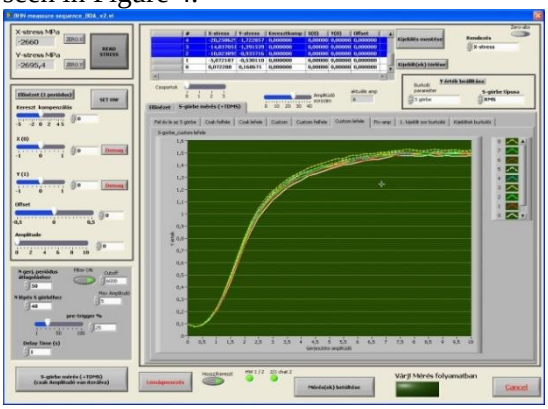

Figure 4. Data handle&storage

Noise measure evaluation and comparison

When as a result of measurement we can indicate the stress dependencies from the mechanical stress with the last module. This module can seen on the Figure5.

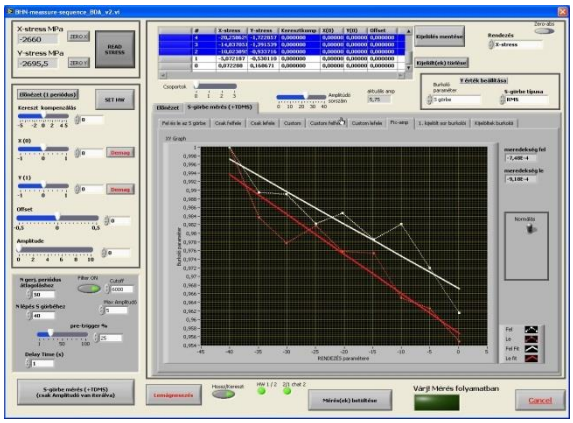

Figure 5. Noise measure evaluation and comparison

III. Results

III.1. Stress ellipse

From BHN measuring we can get the stress ellipse as a result. If we rotate the magnetic field, and detect the noise in different degrees in controlled stress state, we can describe the stress changing in the examined area.

Our current goal to create sufficiently measuring head to get better resolution of the examined material stress state, but avoid the too small magnetic field, which cause smaller Noise avalanches and undetectable effects. We have to optimize the size to get the best result.

In normal stress state, if we don't have remaining stress in the sample we will see a circle when we examine with BHN technique (fig1 left side) If the sample

is in controlled stress state in this case we can follow the stress ellipse, and examine the stress state and directions of the sample(Fig.1. right side).

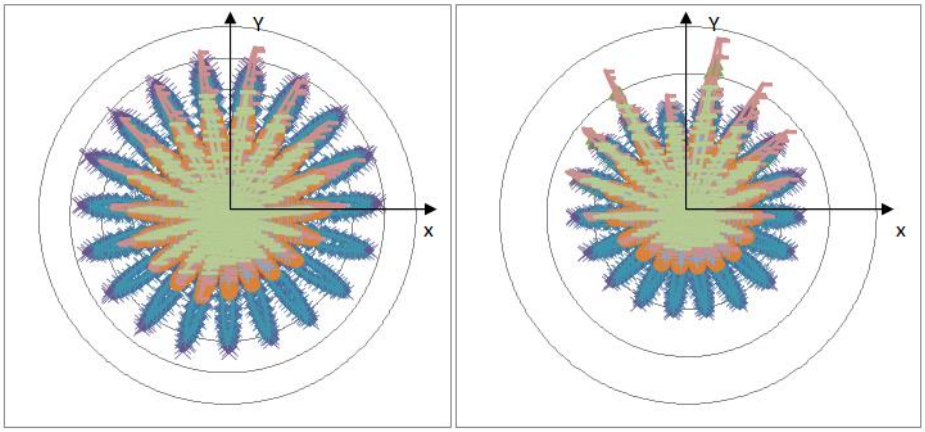

Figure 6. Stress ellipse in normal and controlled stress state / 10° resolution

III.2. Combined stress state

We made experimental tests to get result of two directional changing of the stress. The stress values were changed from 0MPa to 50MPa by 10MPa steps in each direction (X-Y). You can follow the stress ellipse changing on the Figure 7 in each step.

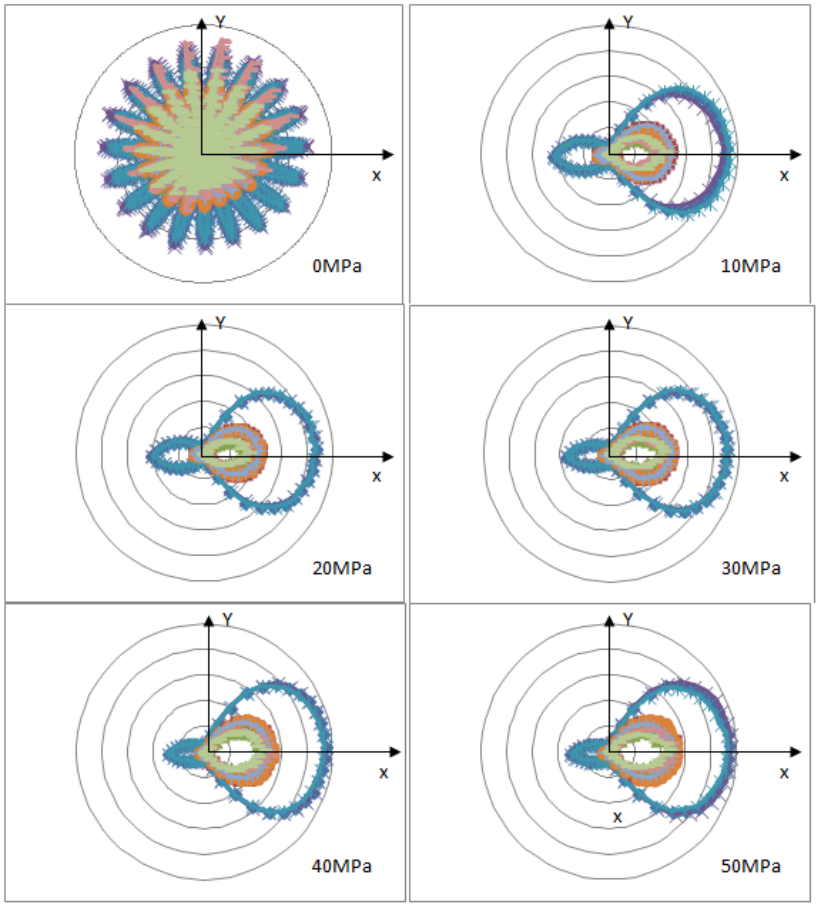

Figure 7. Stress ellipse in normal and controlled stress state / 10° resolution 0-50MPa stress state

By measuring of this stress ellipses in each grid point of the sample we can build up the stress state map of it. When the size of the measuring head is optimized it'll be available to build up the total stress state map of the material, with the ability to follow the stress state changes in different positions. Also the remaining stresses are detectable by this system. The next step has to be the optimization of the head to get the best result.

Acknowledgements

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References

[1] Gábor Balogh, Dr. István Szabó New procedure to combine CAD modeling FEM simulation and Barkhausen-noise stress analysis in sheet metal forming – Acta Physica Debrecina 2012