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Development of Automated System for Calibration of Barkhausen Magnetic Noise Testing

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1. Introduction

In ferromagnetic materials, such regions with uniform magnetic orientation are called magnetic domains. These identified domains are magnetically oriented randomly in the material, in such a way that the general magnetization is null in a non-magnetized state.

When a variable magnetic field is applied to the material, the movement of the domains networks takes place generating displacements that tend to form larger domains. This movement is not continuous, but performed in leaps, and depends on a series of micro and macro-discriminated factors of the material. On the other hand, this movement generates magnetic pulses that can be measured as a sequence of voltage pulses through a reading coil, placed on the surface of the material. The signal measured is know as Barkhausen Magnetic Noise, having this been discovered by Heinrich Barkhausen in 1919.

The non-destructive test method based on the analysis of Barkhausen magnetic noise (RMB) makes it possible to obtain information about the microstructure of the examined material and the state of stresses present in it.

The Barkhausen Effect is characterized by abrupt changes in the magnetization of a ferromagnetic material when subjected to a variable magnetic field. These changes appear as small steps in its H-B curve, which can induce, in a sensor coil, voltage pulses whose sum is called Barkhausen magnetic noise (Figure 1) [1]. This electrical signal can be digitized, filtered and subjected to various types of analysis that enable the extraction of information used in evaluating the material.

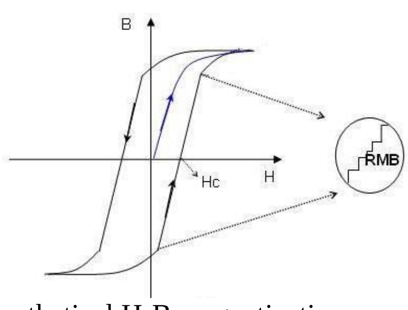

Figure 1 – Hypothetical H-B magnetization curve and RMB [1]

Because mechanical stresses in a material affect the RMB, one can use this test to assess them. RMB testing is widely used for this purpose, as knowing the residual mechanical stresses present in a material is critical in some applications. However, the RMB test has some peculiarities that make it prone to measurement errors when done manually, and these errors are even more undesirable in the test calibration process [1].

Furthermore, as in many applications the stress field present in the material can be too complex to be represented by a uniaxial model, this work proposes the use of a biaxial stress model.

Thus, it is proposed the development of an automated system, with graphical interface, for applying biaxial stresses and measuring RMB for calibrating test measurements by RMB (Figure 2). The system will allow for an easier, faster and more accurate calibration, enabling the Laboratory of Non-Destructive Testing and Automation (LABEND) to carry out new work on the application of the test.

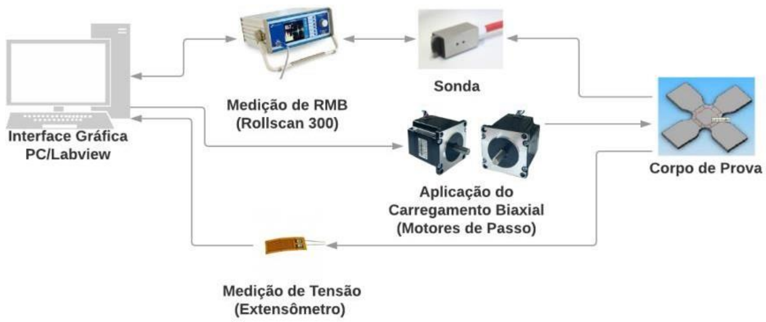

Figure 2 – Schematic diagram of the system under development.

2. Methodology

In order to understand the RMB assay, a study was made about its foundations and applications, having read works developed in the CDTN or externally. In addition, a literature review on biaxial tensile testing machines and their specimens was carried out to understand their construction and operation [2]. With this research, the ISO 16842:2014 standard was found, which aims to standardize the specimen for biaxial traction tests [3]. The study on the method of measuring strains by extensometry was started [4].

Interdisciplinary meetings were held in order to discuss the construction of the stress application module, in addition to discussing the lessons learned from the construction, in a previous work, of the biaxial traction machine present at LABEND and the possible solutions for its malfunction. The biaxial traction application module is in the design phase; for the specimen, a preliminary design was made.

For the development of the software for the control and interface of the system, the LabVIEW environment was chosen, which is widely used for control and measurement applications, through I/O interfaces. After a period of learning about the environment, its programming language and its acquisition devices, the development of the software was started, which after completion, will allow the execution of loading and measuring application routines of RMB in the specimen, with a User-friendly interface.

3. Results and Discussion

The initial idea of the work would be the adjustment and modernization of the biaxial traction machine present at LABEND, which has alignment problems, but after analysis, it was decided to build a new machine, which is under project, as mentioned above. The operation control software is being developed with four modes of operation, two of which already have the initial version developed. An important point that still needs to be developed is the communication between the RMB measuring equipment (Rollscan 300) and the software under development.

The specimen has already been designed (initial project) in accordance with the standard [3] (Figure 3) but it can still be changed, after running a numerical simulation for verification.

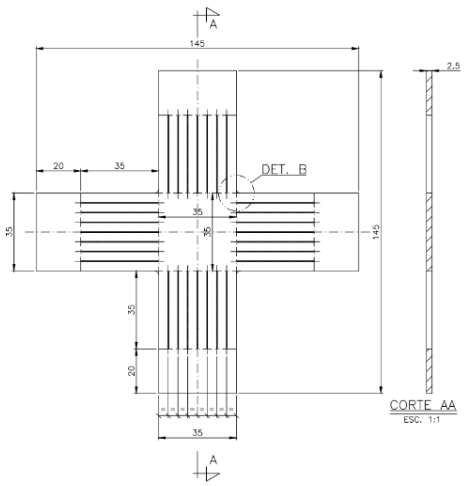

Figure 3 - Specimen

4. Conclusions

It was possible to study, design and execute a considerable portion of the work, including the control of the motor that applies tension to the specimen. With the current job it is possible to apply a voltage to a uniaxial specimen.

For future work we can include the control of Rollscan over Labview with communication through the TCP/IP protocol package, in addition to developing the actual biaxial machine.

The remaining work is expected to remain about a year, where it must be deployed primarily on a uniaxial machine.

This is a complex and interdisciplinary technological development work that will require time and synergy to complete.

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