# INVERSE METHOD TO DETERMINE THE PLASTIC STRESS STRAIN CURVE FROM NON CONVENTIONAL TESTS

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## 1. INTRODUCTION

The plastic stress strain curve that defines the plastic yielding is usually determined by standard uniaxial tests, as simple tension or compression. Conventional tests do not require complex finite element simulation to calculate the stress distribution at the transversal section under study but also have some drawbacks and limitations. The specimen size for example or the necessity to determine the mechanical properties of a forming component could require non conventional test.

A new methodology to determine the plastic stress-strain curve of a material from multiaxial tests has been proposed by the authors. The basic idea is to combine experimental results, finite element simulations and an iterative algorithm to adjust the numerical results with experimental data. The original algorithm, proposed initially for ring compression test, has been generalized and successfully applied to ring tension test and notch round specimens. The process has been used to calculate the plastic stress strain curve at a zirconium alloy nuclear fuel cladding, at two temperatures, 20°C and 300°C and at A533 steel at room temperature. Stress-strain curves were obtained with an almost perfect fit between experimental and numerical results.

## 2. FORMULATION

To obtain the plastic stress-strain curve, an iterative process was suggested in a previous work [1]. The basic idea is to modify the strain-stress curve in each iteration reducing the differences between the numerical and experimental results. The input of the procedure is an experimental curve in which plastic behavior could be observe, as for example the load-displacement curve P-d that appear in Figure 1.

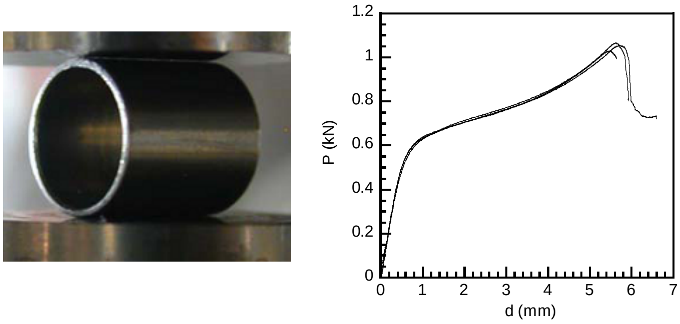

**Figure 1.** Input: Experimental load-displacement curve

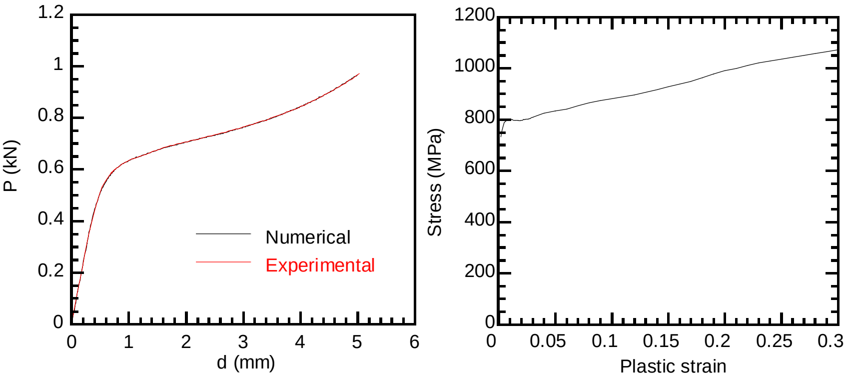

**Figure 2.** Output: Numerical and experimental fitting and plastic stress-strain curve.

The final output is a plastic stress-strain curve that reproduces numerically the experimental data (Figure 2).

## 3. VALIDATION AND GENERALIZATION TO OTHER NON CONVENTIONAL TESTS

The methodology proposed for ring compression tests has been extrapolated and validated in other non conventional tests: the ring tension tests and the tensile notch round test.

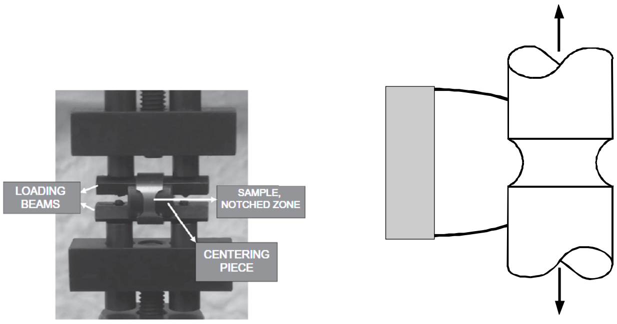

**Figure 3.** Ring tension and tensile notch round tests.

The ring tensile test consists basically in applying a force inside a tube sample, by means of two half cylinders [2] (see Figure 3). This test has been used to obtain the stress–strain curve in the hoop direction from the experimental load vs. displacement in zircalloy [2, 3].

The notch round tensile test has been extensively used to analyze and measure fracture properties and, applying the algorithm proposed, could be useful to determine the plastic strain curve beyond the necking of simple tension test. The procedure has been applied successfully to A533 steel.

## 4. CONCLUSIONS

In this paper an original method was proposed to obtain the plastic stress-strain curve from ring compression test, ring tension test and notch round specimens. The algorithm combines numerical and experimental data in an iterative process.

### References

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