

DYNAMICAL TENSILE DEVICE OF CEA/SEMI/LECM

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ABSTRACT :

To fulfill the needs of the safety programs the LECM has transformed the dynamical tensile machine which is installed in hot cell.

New piloting and acquisition systems have been installed, allowing an automatization of the test references and the acquisition of information.

All the system (hydraulic jack, temperature regulator) is piloted by a PC thanks to an adapted software. It allows strenght and displacement automatic control, and also produces temperature ramps.

Acquisition cards which have two waves and sampling frequency about 160 kHz maximum, allow rapid measure of strenght and displacement. Then it is possible to record 500 to 1000 points on each wave (strenght and displacement) during a period of 20 ms.

This new system, easier to use, allows exact adjustments and specially allows acquisition of many points during speed tests.

INTRODUCTION

The LECM¹ (Laboratoire d'Etudes et Caractérisations des Matériaux) located at CEA/Saclay studies the irradiated materials. One part of it is especially devoted to mechanical testing. This laboratory is included in the High Activity Laboratory on the CEA Saclay Center where are installed a series of hot cells (figure 1) giving a large possibility of mechanical characterization of irradiated materials.

We will describe hereafter the LECM dynamical tensile device which has been transformed in 1995.

¹ Material Study and Characterisation Laboratory

DESCRIPTION OF THE DEVICE

In the frame of the French safety programmes on Reactivity Initiated Accident, mechanicals models have been developed and require mechanical test results as input data.

The tensile machine used to realise this test is installed in hot cell equipped with two remote telemanipulators as shown on figure 2. The tensile machine is a hydraulic one manufactured by the MAYES company. It comprises two different servo valves to pilot the actuator : one for slow strain rates (from $15 \cdot 10^{-4}$ mm/s up to 2 mm/s) and an other one for the high strain rates (from 2 mm/s up to 500 mm/s).

The load is measured with a 500 kg load cell (figure 3). A 100 mm displacement gauge registers the displacements of the actuator. It is placed under the hot cell. The strain is deduced from the actuator displacement.

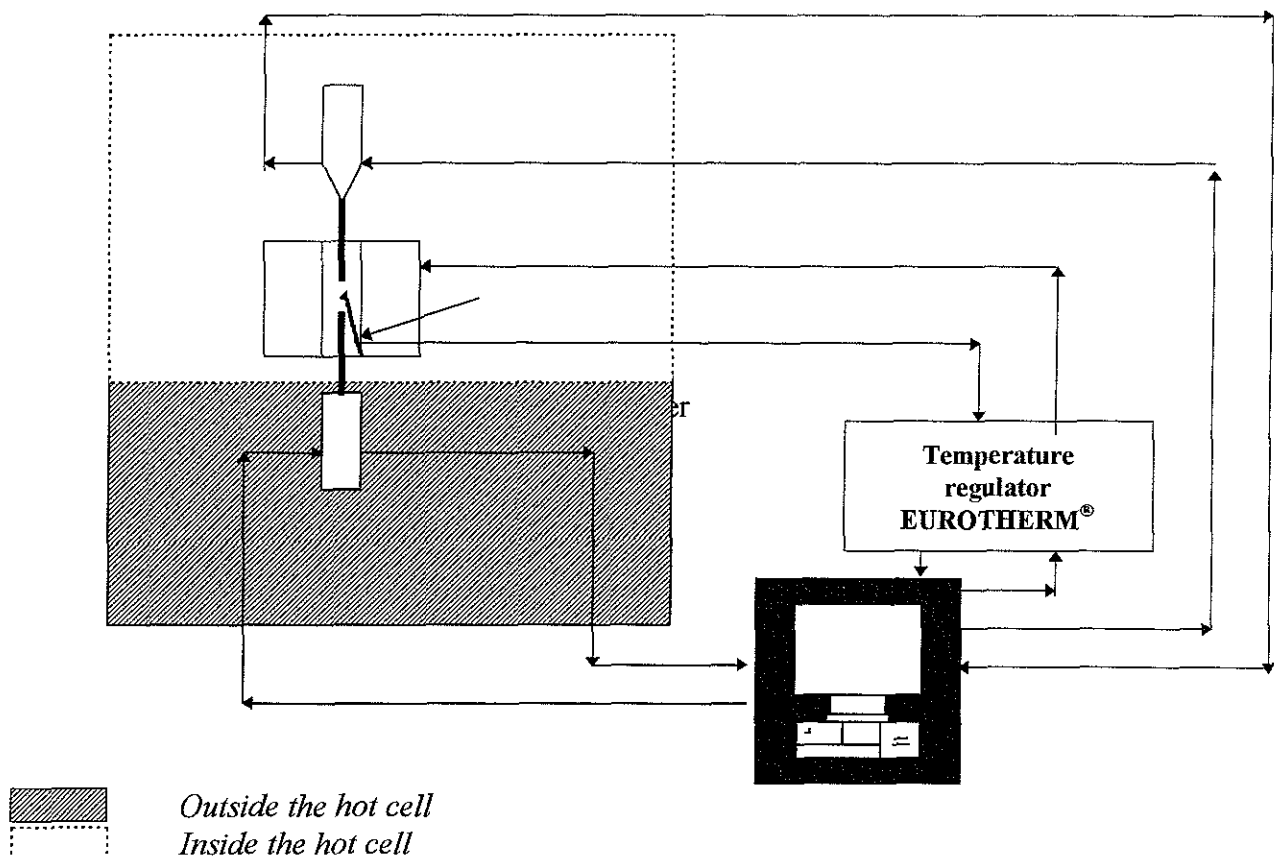
The tests can be performed from 20 °C up to 1100 °C. From 20 °C up to 480 °C hot tests are performed in a vertical furnace with a heating rate about 0,5 °C/s and a thermal stability about $\pm 0,1$ °C. Beyond 500 °C (to avoid any annealing before the test), heating is realised by Joule effect with a maximum heating rate about 500 °C/s.

Main characteristics of the machine are summarized in the table 1.

Due to problems met on the old control unit, the LECM has decided in 1995, to transform and improve the piloting and acquisition systems.

Nowadays, all the system (hydraulic jack, EURO THERM[®] temperature regulator) is driven by a PC thanks to an adapted software. It allows strenght or displacement automatic control and also produces temperature ramps.

The working principle is described below :



Thanks to this system, it is possible to program varied strenght or displacement ramps.

- For instance :
- Constant ramps
 - Cosinus
 - Sinus
 - Triangle
 - Square
 - Or a mixing of all ones.

The acquisition is made by new acquisition card that allow to register 500 to 1000 points on two waves (one for the strenght and one for the displacement) during a period of 20 ms. Its sampling frequency is about 160 kHz maximum.

DESCRIPTION OF THE SAMPLES

All the irradiated materials tested in this cell, come from fuel rods. The fuel has been previously removed by chemical defuelling. Then the zirconia layer has been removed. So the samples have to be prepared. The technique used is electro erosion. Special electrodes are machined with the "negative" shape of the required sample.

Two kinds of samples could be made :

- axial sample (figure 4) in order to test axial mechanical characteristics. It is machined from a 60 mm piece of cladding.
- ring sample (figure 5) in order to test transverse mechanical characteristics. Six rings are machined from a 40 mm piece of cladding (the width of the rings is 5 mm).

EXAMPLE OF DYNAMIC TENSILE TEST

We had to realise for safety programs, specific axial and ring tension tests :

The tests started with a temperature ramp until the required temperature (from 280 °C to 600 °C). Thermal dilatation was compensated by load regulation. Then immediately after the final temperature was reached, the tensile test was run with different strain rates : from 0,03 mm/s up to 75 mm/s (depending on the gage length).

Results of tests are shown on figure 6 : we can see the great number of points in each test in spite of the test conditions.

ACKNOWLEDGMENTS

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LECM CEA-Saclay
CONSTRUCTOR : CEA + TEMA CONCEPT

WORKING CELL 11 : Dynamical tensile test machine
MODIFY in : 1995

PERFORMANCES :

■ Tensile machine load and position controlled

Actuator displacement velocity : $0 < V < 500$ mm/s
Load cell capacity : 5 kN
Displacement transducer stroke : ± 50 mm

■ Heating by vertical furnace

Control by sample thermocouple
Temperature ramp rate : $0,5$ °C/s
Maximum temperature : 750 °C
Precision : ± 2 °C (TC in contact with sample)
Stability in temperature : ± 1 °C

■ Heating by Joule effect (50 Hz)

Control by sample thermocouple and analogical regulator
Temperature ramp rate : 500 °C/s
Maximal temperature : 1250 °C
Precision : ± 2 °C (TC in contact with sample)

■ Digital acquisition with DT 2836 acquisition cards

Sampling frequency : 160 kHz
A/D converter resolution : 16 bits
Number of channels : 2

■ Computer analysis of test results

Adjusting by CEA

Table 1 : Main characteristics of the LECM dynamical tensile test machine (CEA Saclay)

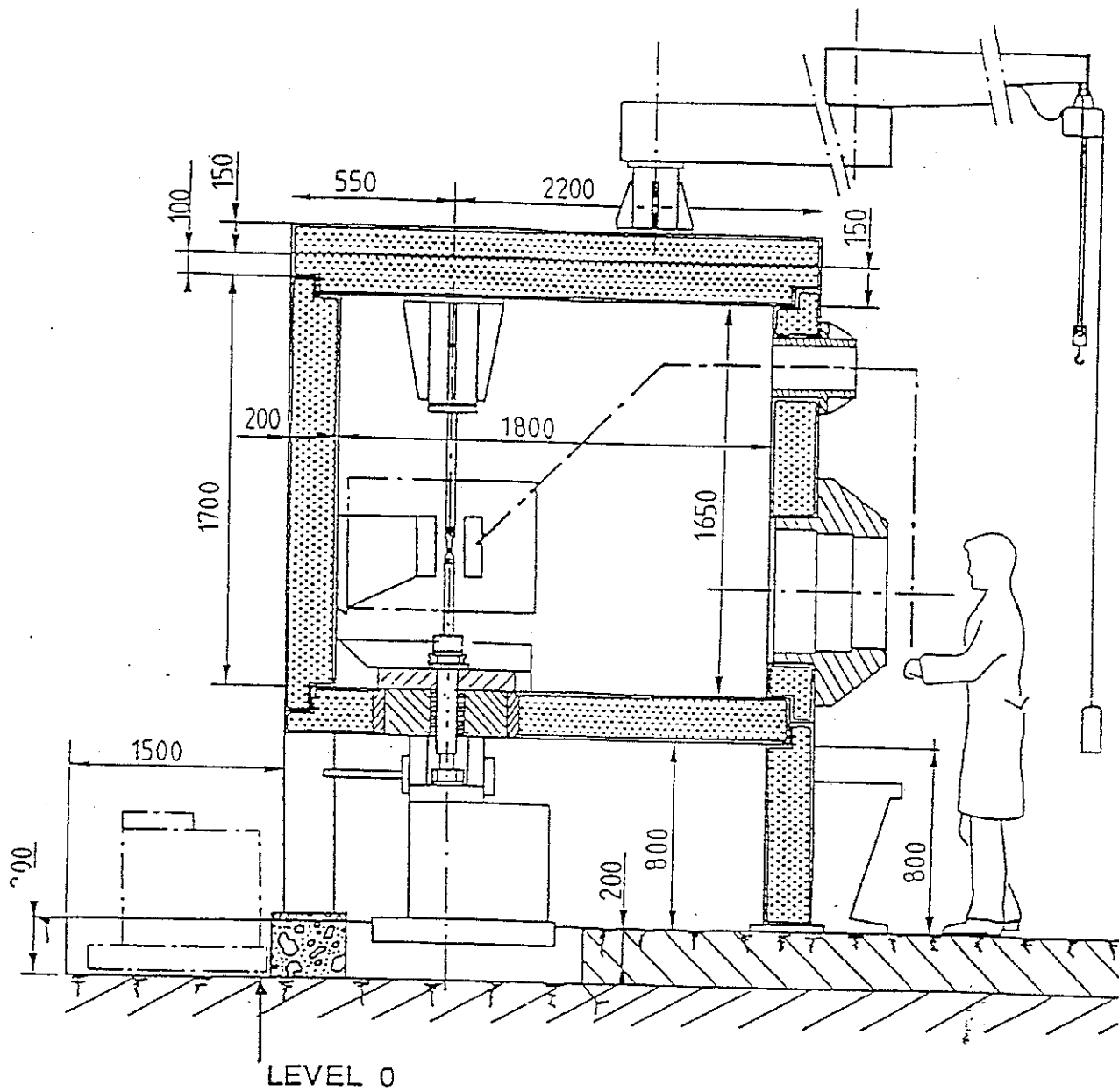


Figure 2 : The LECM dynamical tensile test machine

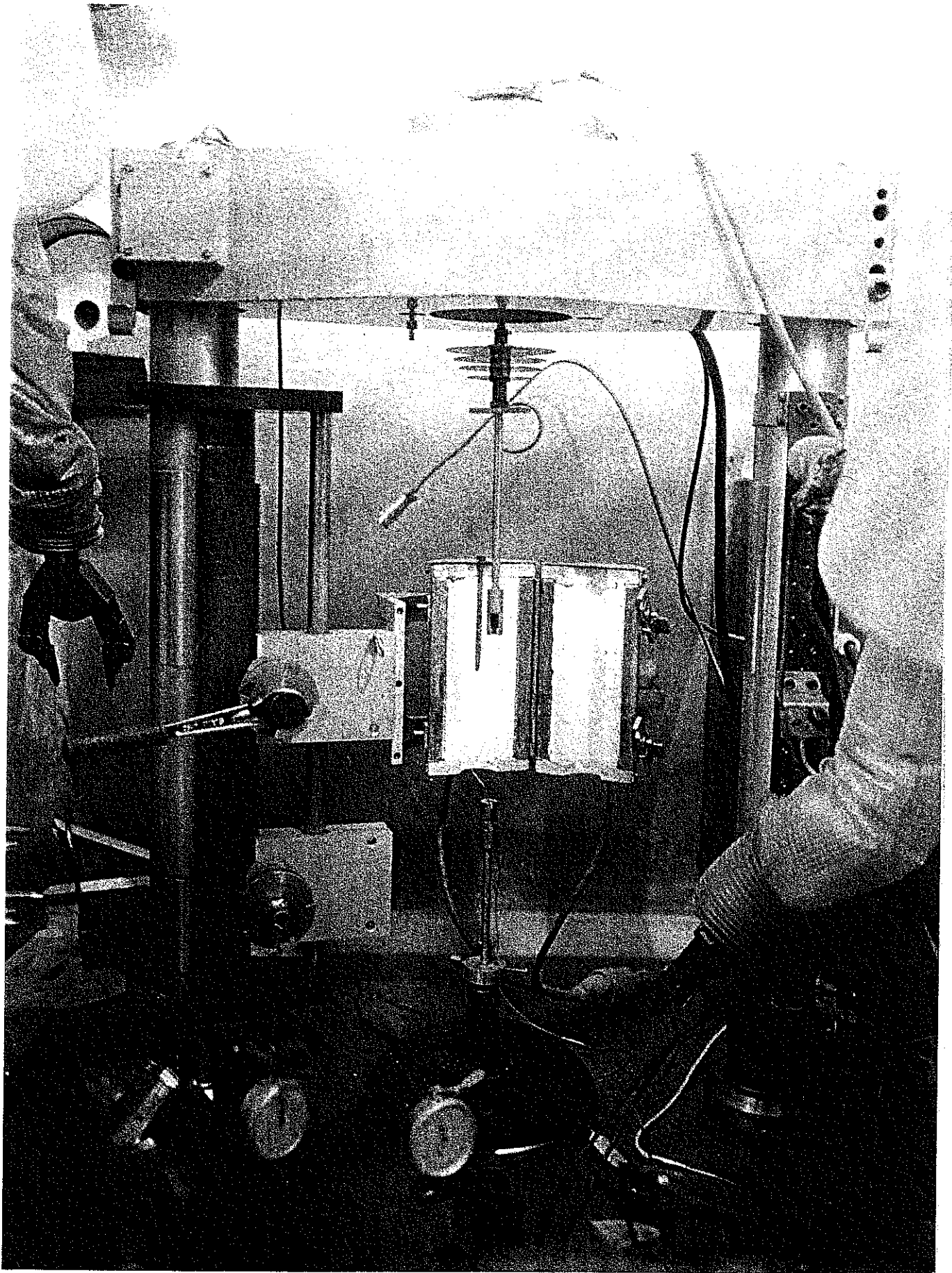


Figure 3 : view of the inside of the cell

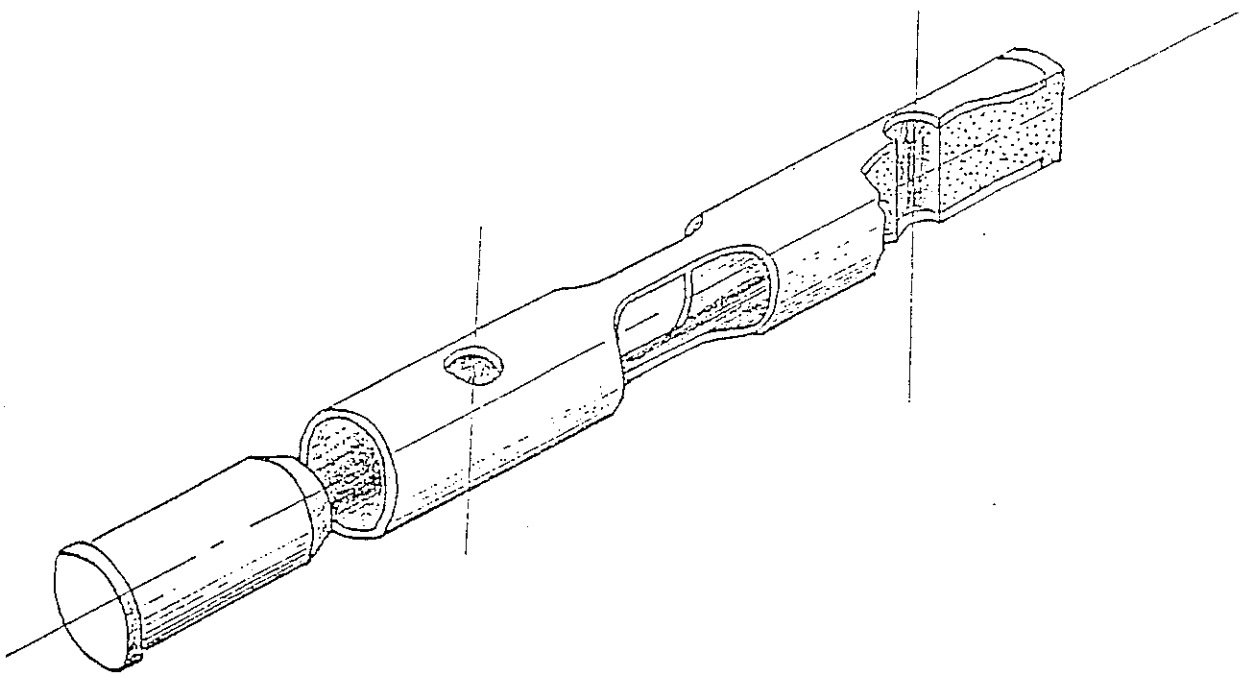


Figure 4 : Axial tensile sample machined from fuel cladding

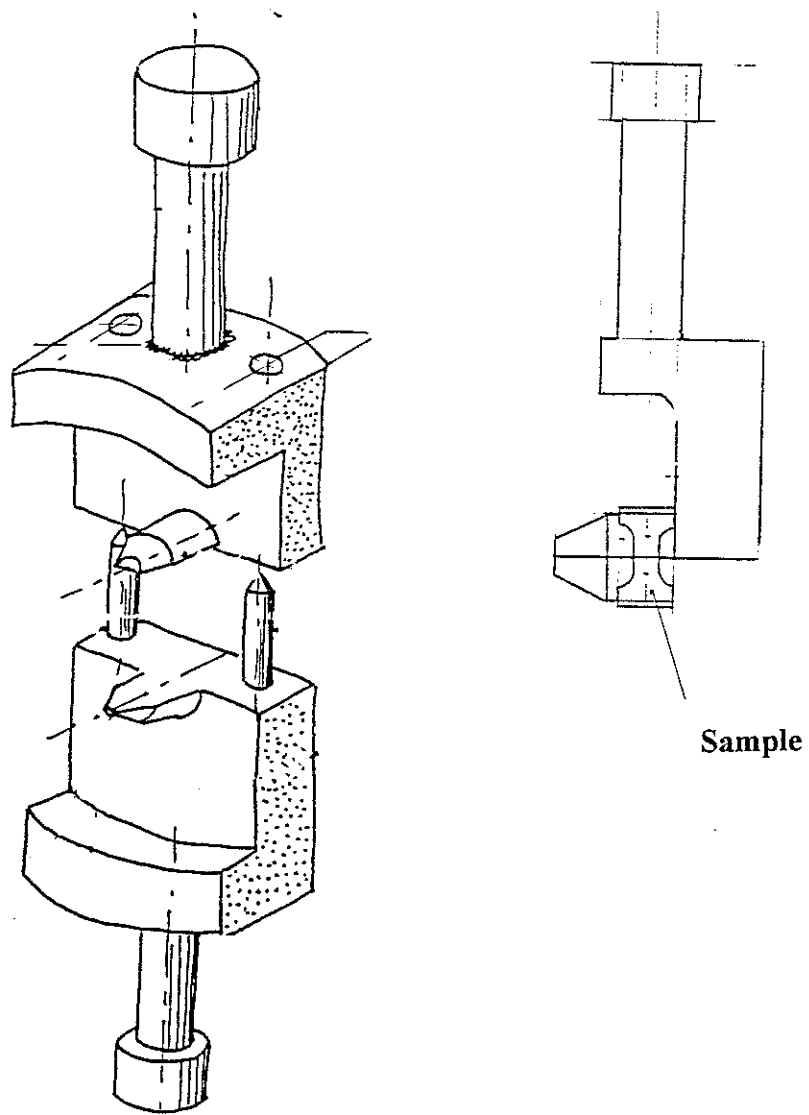


Figure 5 : Transverse tensile test

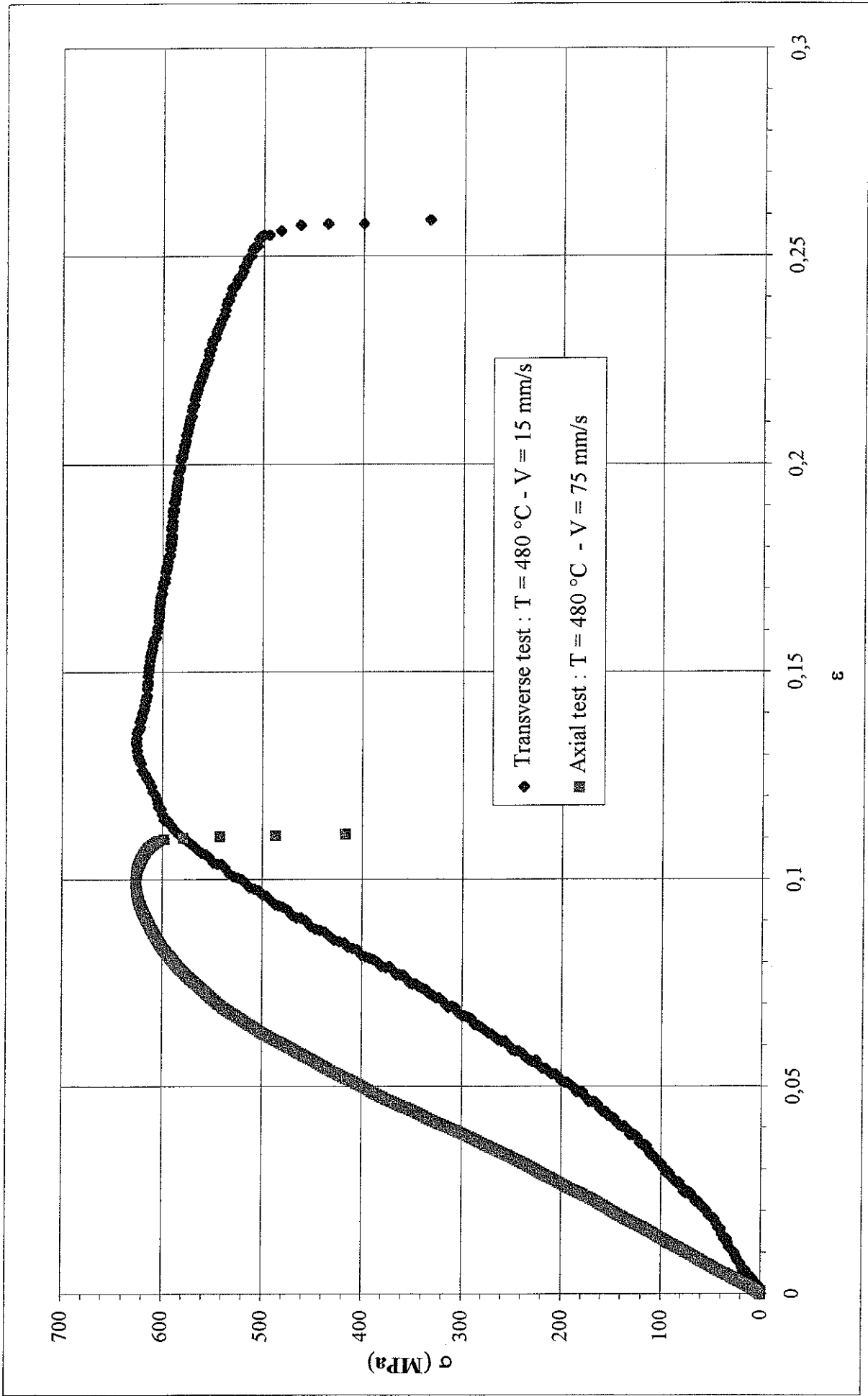


Figure 6 : Results of dynamical tensile tests