



Virtual tensile test machine as an example of Material Science Virtual Laboratory post

L.A. Dobrzański*, A. Jagiełło, R. Honysz

Division of Materials Processing Technology, Management and Computer Techniques in Materials Science, Institute of Engineering Materials and Biomaterials, Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, Poland

* Corresponding author: E-mail address: : leszek.dobrzanski@polsl.pl

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Education and research trends

ABSTRACT

Purpose: of this paper is to present virtual strength machine from material science virtual laboratory, which can be used for laboratory staff or students training. Material Science Virtual Laboratory, is an open scientific, simulating and didactic medium helpful in the realization of the didactic and educational tasks from the field of material engineering in Institute of Engineering Materials and Biomaterials of the Silesian University of Technology in Gliwice, Poland.

Design/methodology/approach: Computer application for simulation of virtual strength machine was written in JAVA and C++ programming language. Main programme was written in NetBeans 5.5 Java Programming Environment.

Findings: Cheap computers and common access to internet network allow use simulator from any place. User can be train at home or at school. This simulator allows training infinite amount of people at once.

Research limitations/implications: This programme only simulate methodology of testing, it doesn't predict any parameters.

Practical implications: implications Virtual laboratory is great idea when we have expensive laboratory equipment and untrained staff to use it. Even after reading user manual use of the equipment is not easy and can lead to equipment damage. It is better to train people on a simulator before first using the real machine.

Keywords: Education and research trends; Computational material science and mechanics; E-learning; Computer aided teaching; Virtual laboratory; Training simulations

1. Introduction

Virtual laboratory is great idea when we have expensive laboratory equipment and untrained staff to use. Even after reading user manual use of the equipment is not easy and can lead to equipment damage. It is better to train people on a simulator before first using the real machine. It is better to train people on simulator before using the real machine. The best simulator should work as real equipment. Sometimes simulator is more expensive than real machine. Purpose of this paper is to present simulator which is easy to use, similar to real and cheaper than real equipment. The incorrect service of the simulated device ends

with damages visible only on the monitor screen. The real device is safe [1-6].

If we have many people to train very important is availability of the virtual machine. For properly work this simulator needs a standard personal computer with any operating system with installed Java Virtual Machine (free software). Device which this paper presents is a virtual tensile test machine. This programme only simulates methodology of testing, it doesn't predict any parameters. Also it will be one of elements of the Material Science Virtual Laboratory in Institute of Engineering Materials and Biomaterials of the Silesian University of Technology in Gliwice, Poland [7-15].

2. Environment

Computer programme for simulation of the virtual tensile test machine was written in JAVA and C++ programming language. Main programme was written in NetBeans 5.5 java programming environment. Borland C++ Builder 6.0 environment was used to write additional application for chart transformation from real machine. Simulated machine was Zwick Z100 tensile test machine.

3. Materials

This version of simulator give access upto 10 samples of materials, which were tested in reality in tensile and compression tests. Available materials and test types are shown in Table 1. The dimensions of tensile and compression test samples are shown in Fig. 1 and Fig. 2, which also show one of the programme windows where the user can select material sample to test.

Table 1.
Materials used for simulation

Material	Test type
16MnCr5,	tensile and compression
X30Cr13,	tensile and compression
X5CrNi18-10,	tensile and compression
X20CrNi172,	tensile and compression
S235JR,	tensile and compression
BSt500S,	tensile and compression
Al.-Pa6 Ta,	tensile and compression
Cu-ETP,	tensile and compression
CuZn40Pb2,	tensile and compression
AlSi9Mg	tensile
MgAl92N1	compression

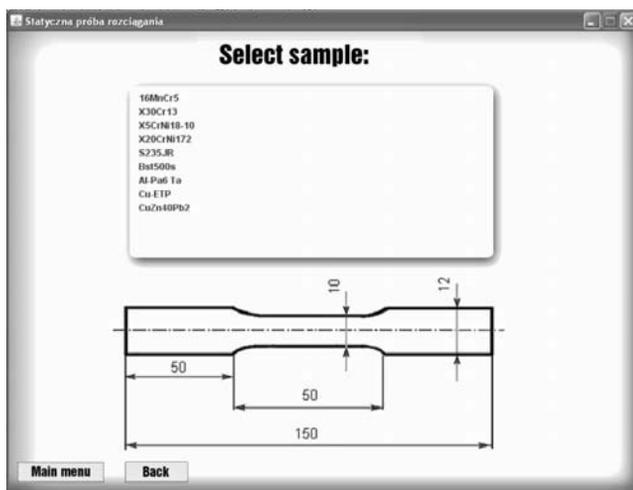


Fig. 1. Tensile test sample selection window

There are some steels, alumina and copper alloys. All dimensions of samples were chosen using standards, for example tensile test sample dimensions are made according to European Standard PN-EN 10002-1:2004.

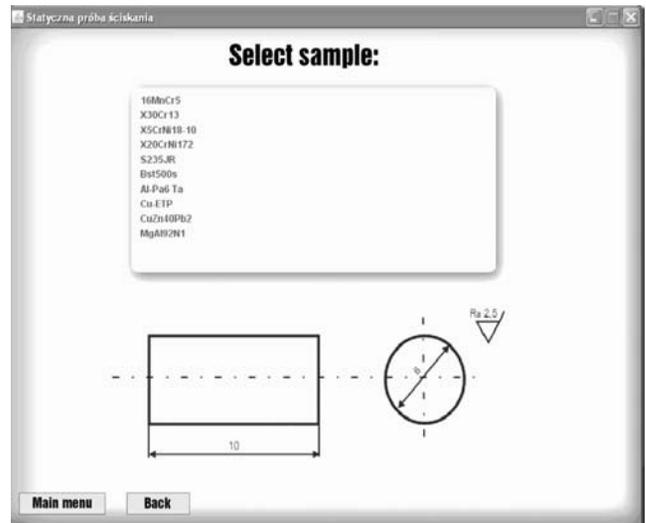


Fig. 2. Compression test sample selection window

4. Interface

The programme is easy to use and shows the user step by step how to carry out tests on tensile test machine. It also teaches user on proper order of steps. When user miss one step he can't do next and he gets a explaining message what he missed and what to do next. First, user must calibrate the device by clicking on calibrate button, and then put sample into machine by clicking on sample picture on screen. Next step is locking handles. Last step is tensile or compression test start. Figure 3 presents tensile test window, where you can find on the left side the machine model and on the right side you can find user help and tensile/compression chart.

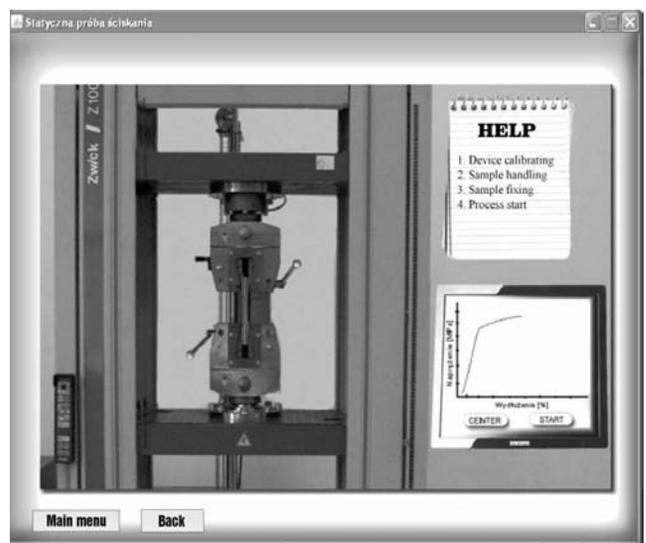


Fig. 3. Tensile test window

The sample in machine during testing is changing dimensions and chart is draw. Also sounds of test are simulated, what makes simulator more realistic. When sample breaks properly, the sound is played, which was recorded during real test. Other sounds are played for steel and other for copper or alumina alloys. After the test user gets a new window with picture of sample after rupture and material strength parameters shown at Fig. 4 and Fig. 5.

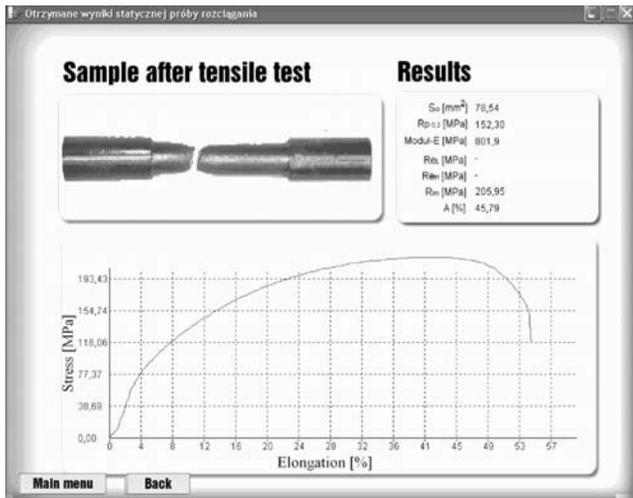


Fig. 4. Tensile test results window

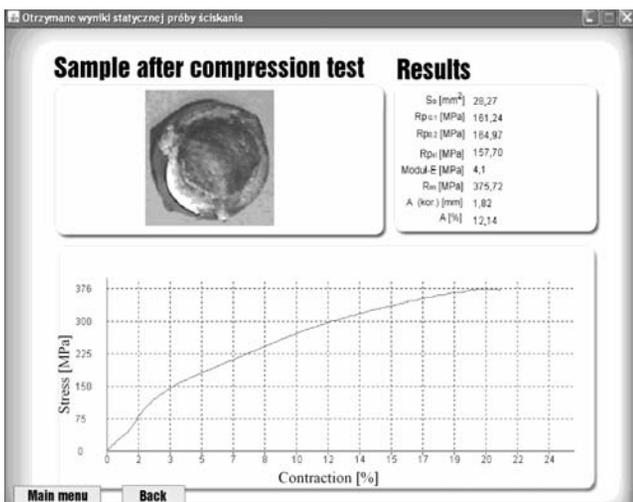


Fig. 5. Compression test results window

5. Programme

The 26 java classes were implemented in this simulation programme. Every class has own methods and executes some functions. Some of them are used for drawing; some read data from xml file into memory, two of them are used for playing sounds.

First activity of programme is loading samples data from xml file into memory.

This file contains samples info with all sample parameters which were received from real test on Zwick Z100 strength machine. Structure of this file is shown at Fig. 6 It can be edited with any text editor. The file structure needs following tags for proper work of this simulator:

- `<rozciąganie></rozciąganie>` for tensile test or `<ściskanie></ściskanie>` for compression test. These blocks can contain infinite amount of samples.
- `<material> </material>` - between these tags we need to put all material data:
- `<nazwa>` - name of material
- `<probka>` - path to file with sample Picture before test
- `<probka_r>` - path to file with sample Picture after test
- `<wyniki>` - results of test for ex. Re value.
- `<wykres>` - chart coordinates prepared using PrepareChart from Borland C++ Builder.

```
<?xml version="1.0" encoding="Windows-1250" ?>
<wytrzymałosc>
- <rozciąganie>
- <material>
- <nazwa>16MnCr5</nazwa>
<probka>probka1.gif</probka>
<probka_r>X30Cr13_r.gif</probka_r>
<probka_mr>probka1_r.gif</probka_mr>
- <wyniki>
<parametr nazwa="SO [mm kw]">78,54</parametr>
<parametr nazwa="Rp 0,2 [MPa]">152,30</parametr>
<parametr nazwa="Moduł-E [MPa]">801,9</parametr>
<parametr nazwa="ReL [MPa]">-</parametr>
<parametr nazwa="Rm [MPa]">205,95</parametr>
<parametr nazwa="A [%]">45,79</parametr>
</wyniki>
- <wykres maxx="40" maxy="638">
```

Fig. 6. XML samples database

6. Advantages and disadvantages

This programme is not ideal simulation, but it's the first version. The following advantages are:

- easy interface
- independent of operating system
- sound simulation
- duration of simulation and test are same
- real test results are presented
- don't need special and expensive equipment
- easy adding new samples
- created by using free software

The following disadvantages are:

- 2d simulation
- Lack of device failure simulation
- Only polish language version
- Minimum screen resolution is 1024x768
- Only 10 materials for testing

7. Conclusions

Cheap computers and common access to internet network allow use simulator from any place. User can be train at home or at school. Most of simulators need special expensive equipment. They are so expensive that many institutions can buy only one and only one person can be train at once. This simulator allows training infinite amount of people at once. This computer simulation is not perfect, but efficiency of staff training is probably better than after reading paper manual. Next version of application will be full 3D simulation, what should make simulation more realistic. Also failures of device will be simulated and english language interface will be made.

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