DIDACTU, an E-learning Tool for Underground Works.

R.M. Faure[1], J.-F Thimus[2], G. Hémond[3]

[1] Centre d'Etudes des Tunnels, 69500 Bron, France.
[2] Université catholique de Louvain, 1348 Louvain-la- Neuve, Belgium.
[3] Solem Expertises SA, Carouge, Suisse.

ABSTRACT:

The authors present there, the co-operative development done since several years, for building an e-learning tool for underground works. The aim of this tool is continued teaching: one doesn't deal with elementary theories, such are continuum mechanics or soil mechanics, but we suppose a sufficient background for the reader, and so one can speak immediately of underground works. With this concept, the main difficulty is the numerical illustration of methods for the immediate identification by the reader of the main parameter among all parameters used by the method. This e-learning tool, called DIDACTU, will evolve in a next future by completing the scope, the chapters Investigations and Materials will be written. A larger cooperation is welcome. DIDACTU is reachable at www.solem.ch or http://lita/gce.ucl.ac.be/~kbt

1. INTRODUCTION

E-learning is the use of networks for teaching methods, theories and sometimes practise with selected images of works. From discussions with others colleagues, all through the world, e-learning is sometime frightening some teachers that believe that the face to face with student is now vanishing. On the other hand, e-learning is available at any time and appears as a solution for crowded courses. Mainly it gives also the possibility of illustrating theories trough calculus managed by the reader. Also one powerful possibility of e-learning is the world wide accessibility, and it is a challenge for countries in which the educational system must be improved.

TC 18 (learning) of ITA looks carefully after the evolution of teaching methods for underground works, and DIDACTU was presented to the working group during the last conference in Amsterdam.

2. THE CHAPTERS OF DIDACTU

DIDACTU shares the site of the world of tunnels with a data base (KBT) of interesting cases of tunnels (see fig 1).
When asking Didactitiel (the link to use DIDACTU), its structure appears immediately in a rule at the top of the screen where one can find the tittles of the six chapters:

- Project (Projet)
- Investigations (Reconnaissances)
- Design (Dimensionnement)
- Digging (Creusement)
- Materials (Matériaux)
- Tunnel life (Maintenance)

The usual approach for e-learning is the one coming from the lecture of a book. The user shall follow this navigation, page after page, for the presentation of the actual DIDACTU.

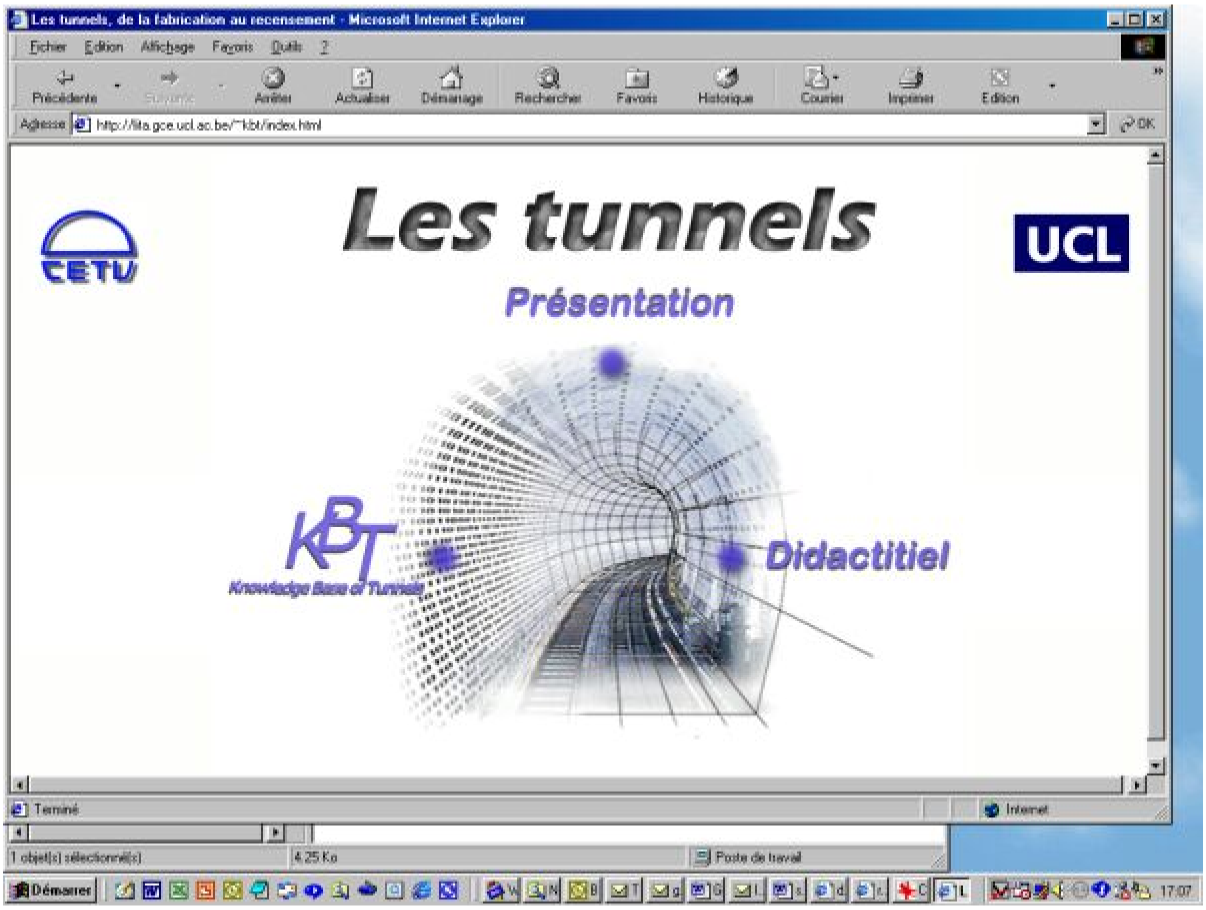

Fig 1: The first page of the site gives the way to Didactitiel (DIDACTU) and KBT.

2.1 Project

This short part, not yet available, will try to give some philosophy for the designer. Underground works are not similar to usual structure works, as the soil and the structure are closely embedded. We have also to take into account the finality of the works and also all safety features that new rules induced now.

2.2 Investigation

This part explains all the kinds of investigations we can do when building a tunnel. This chapter will be a description of methods of investigation.

2.3 Design

This chapter is the most developed, and includes on line codes for calculations. At the end of this chapter, the user has the possibility to compare the different methods (strain and stress of the rock mass and of the lining). We have the following sub sections:

2.3.1 Introduction

This introduction wants to present the methods that are used for the definition of the lining of the tunnel and the main parameters that we find in all methods. For each method presented, an "passport" of it can be popped up and gives to the user the hypothesis used by the method. A classification of methods is presented, from the less complex method for circular tunnel in homogeneous and elastic material, to more complex as a horseshoe-shaped tunnel computed with finite elements method.

2.3.2 Empirical methods

In this part we find the methods developed by Therzaghi, Barton, Bieniawski (see fig 2), Hoek-Kaiser-Baden and the AFTES method; this last one is generally used in France, Switzerland and Belgium.

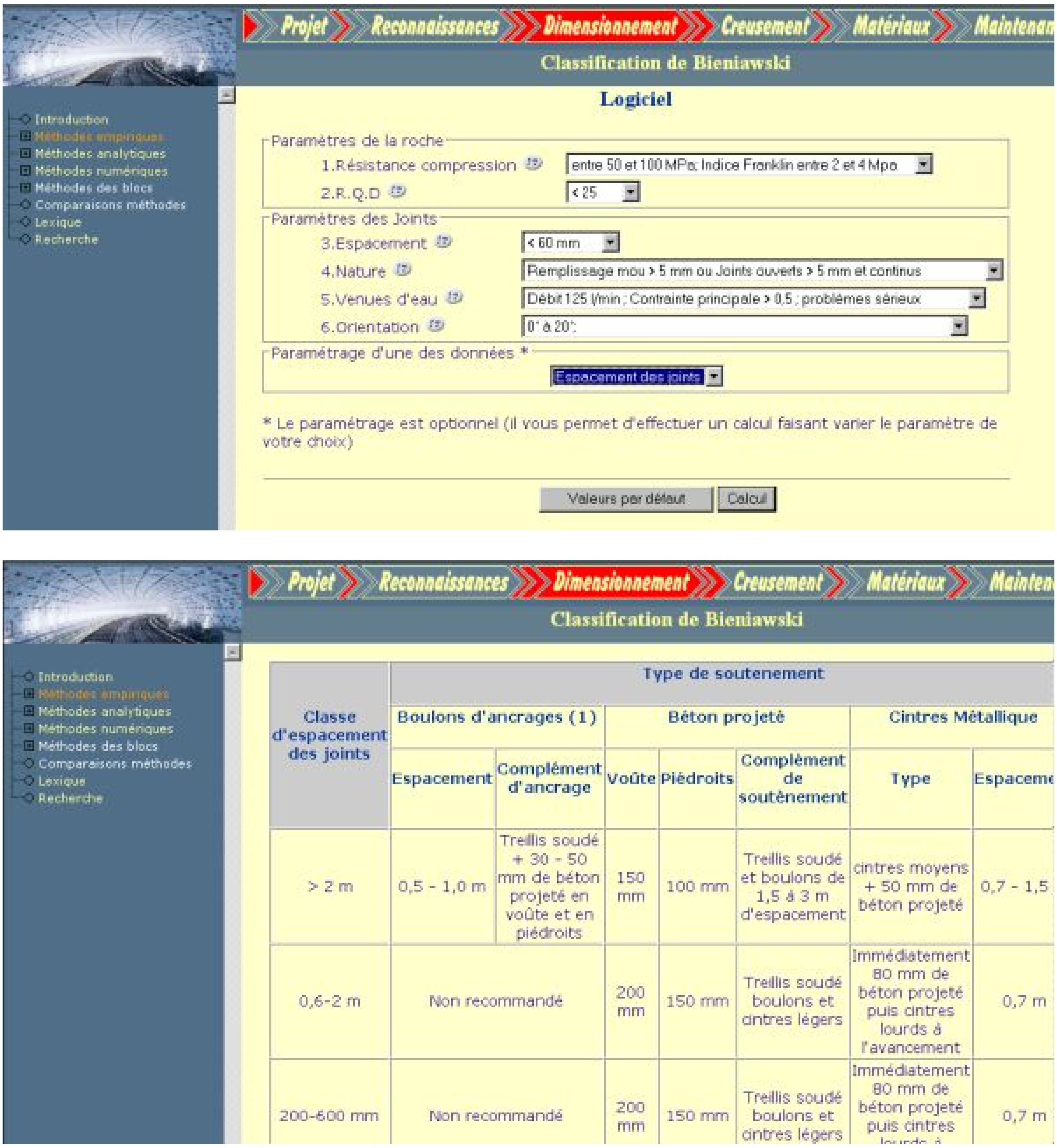

FIG 2: These two screens show the input and a part of the results of the Bieniawski Method

For the AFTES method that recommends the kind of support, the input of data needs two screens, but all along the input the user is aided by the display of definition and the range of each parameter, and the results are presented as shown in fig 3 and fig 4.

An interesting capability of this e-learning is the parametric calculus for an unknown parameter, giving to it several values for making a curve which shows the influence of the selected parameter.

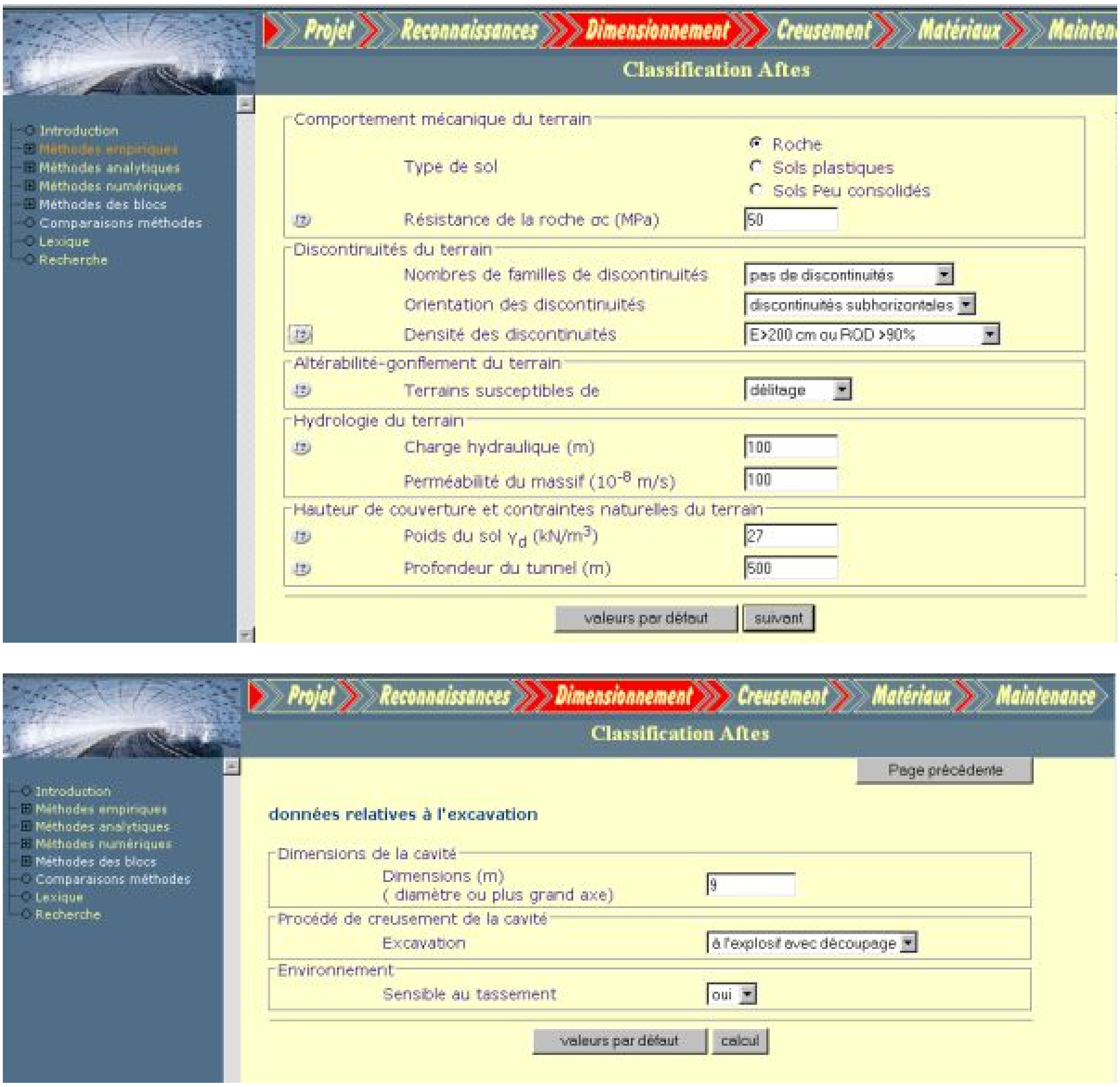

Fig 3: The two input screens for the AFTES method.

2.3.3 Analytical methods

The analytical methods developed in DIDACTU are the methods of Lamé, Kirsch, Einstein-Schwartz for elastic media. For elasto-plastic media we can find the method of Panet completed by Detournay for a media with an anisotropic pre-existing stress field.

Limit analysis is also represented by the methods of Caquot, Atkinson and Potts, and Mühlaus and these three methods are presented together as we have the same data.

2.3.4 Numerical methods

Finite elements method and boundary elements methods are presented. With FEM, pre-defined cases can be computed (circular, rectangular and horseshoe-shaped sections). At this time, only a presentation of BEM is done. The method of discrete blocks is also shortly presented.

2.4 Digging

This chapter describes the machines and all methods that are used for boring a tunnel. First is given a theoretical description of the different methods of excavation, of the supports and linings. After the choice of the excavation technique and the solution to some problems encountered are presented.

Fig 4: The output of the AFTES method in a graphical manner.

2.5 Materials

This sub section is presently under construction. With the development of new materials, especially concrete that is now used for different purposes, it is compulsory to describe accurately the benefits or the disagreements we can find with a good or a bad use of this material. A special part will be devoted to the behaviour of concrete under a fire load.

2.6 Life of a tunnel

As all works, a tunnel must be inspected to prevent repairs. In this part (not yet available) of DIDACTU we will present the different operations that tunnel operators use to do for the benefit of the users.

3. ON LINE CODES

All the codes presented in DIDACTU are either re-written in PHP language, either modified to be run with files (data and results), these files being managed by PHP commands. PHP is chosen because it is an easy to learn language that can be use in its own computer for debugging before setting the code in a server. PHP allows also the building of easy to use interfaces, with pop windows for giving, in context, explanations to the user.

For simple algorithms the code was directly written, but for finite elements method, as data are very numerous, we have to find how to reduce them. For demonstration and teaching use, as it is done in DIDACTU, we choose some pre-defined cases with a small number of parameters, and the mesh is predefined and chosen from a sketch (see fig 5).

4. COMPARISONS

With DIDACTU, it is very easy to compute the same tunnel calculation by several methods and to discover the influence on the result following the hypothesis hidden in each method. This approach is very useful when teaching, as it supports the comprehension of the theories.

Fig 5: The choice of a mesh is done by clicking on the chosen mesh.

5. AS A CONCLUSION, NEXT IMPROVEMENTS

The authors want to develop in the future the section of KBT (Knowledge Base of Tunnels) by improvements of the tunnels already coded and by addition of new topics. During the coming years, we have to set chapters Investigations and Materials. We hope that we can find help from students but also from companies that have a lot of pictures and interesting references.
We think also to develop a new navigational system based on case design, as for example, when we design a tunnel in soil, it would be helpful to hide all information about rocks and to give access to information dealing with this soil.

6. ACKNOWLEDGEMENTS

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