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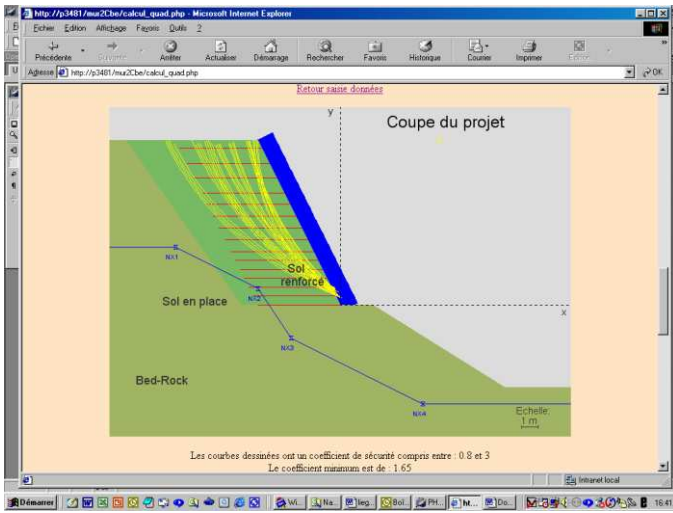


Figure 2. A part of calculus display

3 E-LEARNING TOOLS

The next step is the melting of on line codes, base of cases and text, building so an e-learning tool. At this time two e-learning tools are under development, one for slopes called DIDACTPENTE, including also retaining walls, the second about tunnels called DIDACTU (Faure & Thimus 2004, Faure et al 2007). In this paper, we will present mainly DIDACTU.

4 PRESENTATION OF DIDACTU

DIDACTU shares the site of the e-learning of tunnels (figure 3). This site was developed by CETu, UCLouvain, ULB and SOLEM.



Figure 3. This first page of the site gives the way to DIDACTU

When asking DIDACTU, its structure appears immediately in a rule at the top of the screen where we can find the topics of the six chapters: Tunnel, Investigations, Design, Realization, Materials and Tunnel

life (CETu 1998). Figure 4 gives de mains topics of the six chapters.

The usual approach for e-learning is similar to the lecture of a book with advantage of links between different parts of those. We shall use this navigation, page following page, for the presentation of the actual DIDACTU.

4.1 Tunnel

This short part tries to give the philosophy of the approach for the designer. Underground works are not similar to usual structure works, because 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.

The different types of tunnels are given (road, railways or hydraulic ways) and a paragraph is dedicated to the problems of intakes.

4.2 Investigations

This part explains all the kinds of investigations we can do before the realisation of a tunnel. This chapter is a description of the main different methods of investigation.

In a first step, the aim of investigations is explained and after one sees the onsite tests and measurements with on-line software for the interpretation of seismic refraction, and the lab tests. A particular attention is bringing to the use of pre-investigation gallery.

4.3 Design

This chapter is the most developed and includes on lines codes for calculations. One presents the methods used for the lining definition of the tunnel and the main parameters needed in the methods. For each method presented an "identity card" of it can be popped up and gives to the user the hypothesis made by the method. A classification of methods is presented, from the less complex method for circular tunnel in homogenous and elastic material, to a horse shoe tunnel computed with finite elements method. We have the following sub sections:

4.3.1 Empirical methods

In this chapter we find the methods developed by Therzaghi, Barton, Bieniawski (fig 5), Hoek, Kaiser and Bawden and the AFTES method, this last one generally used in France, Switzerland and Belgium.

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; the results are presented in a graphic manner (fig 5)

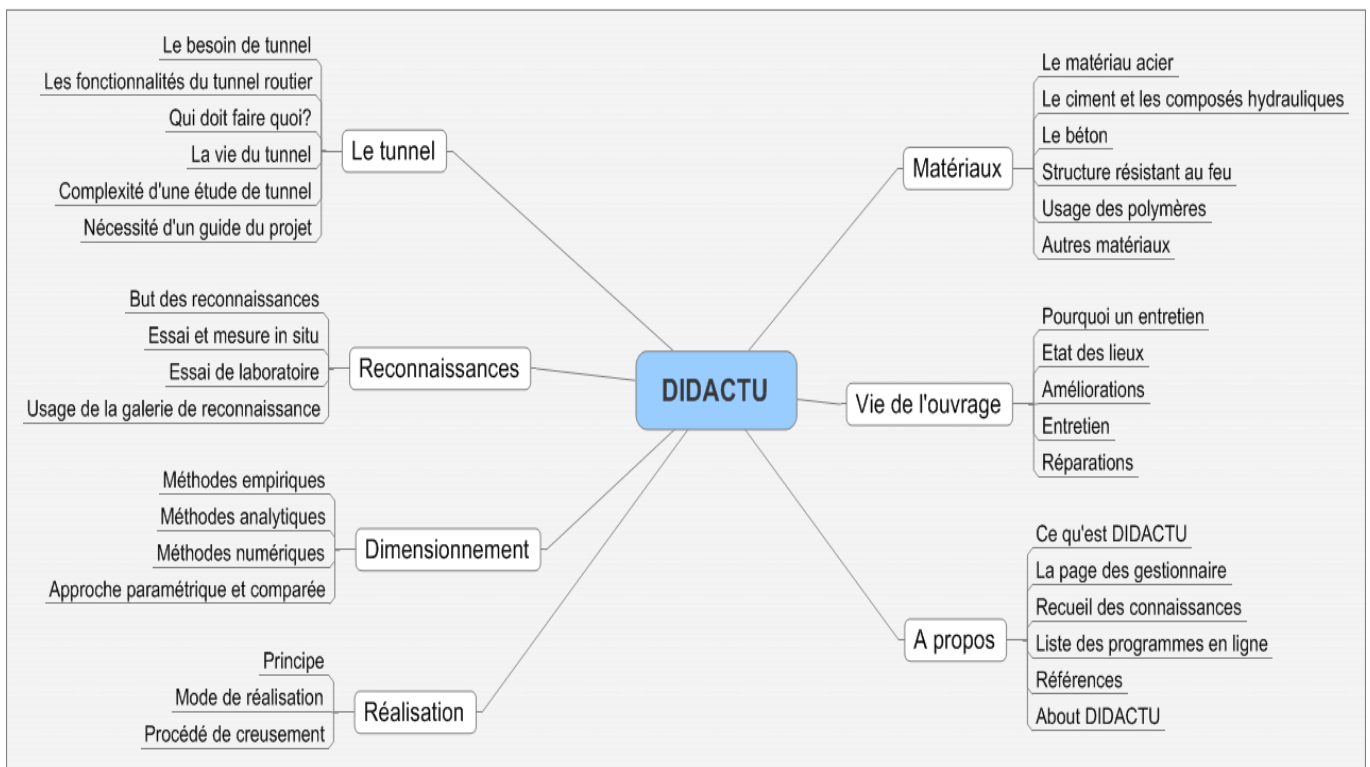


Figure 4. The different chapters and topics of DIDACTU

An interesting capability of the codes is the automatic parametric calculus, giving to it several values for making a curve showing the influence of the selected parameter.

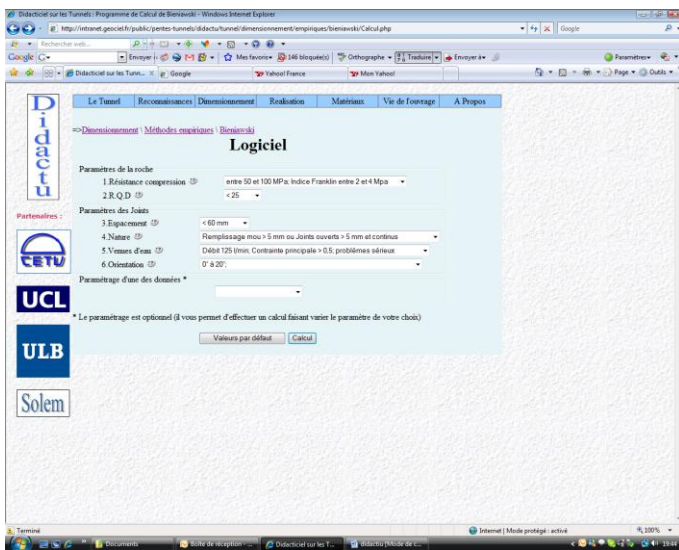


Figure 5. Input screen for Bieniawski method

4.3.2 Analytical methods

The analytical methods developed in DIDACTU are the methods of Lamé, Kirsch, and Einstein-Schwartz for elastic media. For elasto-plastic media, we can find the method of Panet completed by the development proposed by Detournay for a media with an anisotropic pre-existing stress field (Fairhurst & Detournay 1987, Fairhurst & Carranza-Torrez 2000).

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

4.3.3 Numerical methods

Finite elements method and boundary elements methods are presented. With FEM, pre-defined cases

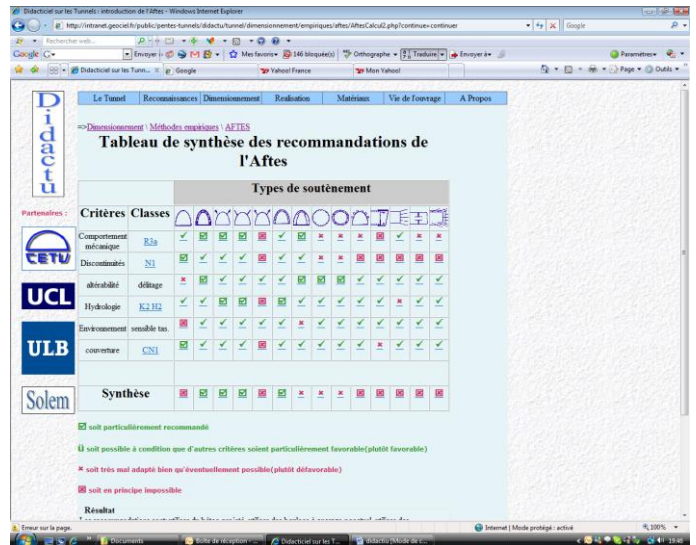


Figure 6. Output of AFTES method in a graphical mode

can be computed by only a presentation of BEM is done, at this time.

All the codes presented in DIDACTU are, either re-written in PHP language, either modified to be run with files (data and results) managed by PHP commands. PHP is chosen because it is 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 pre-defined and chosen from a sketch. (figure 7)

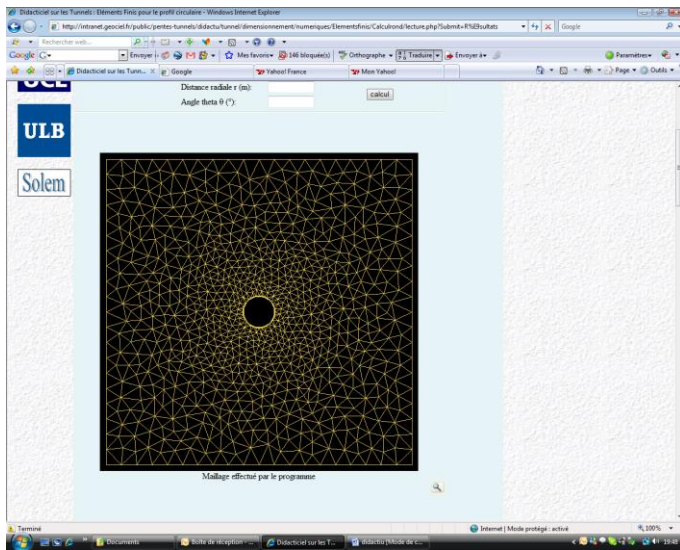


Figure 7. The choice of a mesh is done by clicking on the chosen mesh

4.4 Realization

This chapter describes the methods and machines used for boring a tunnel. Different topics are boarded: principle and methods of realization, pre-support and support of face, support, lining, watertightness and survey of execution (AFTES 1993a, 1993b).

4.5 Materials

With the development of new materials, especially concrete 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. Other information is also given on others materials as steel, cement and grouting, and use of polymers. A special part will be devoted to the behaviour of concrete under a fire load.

4.6 Life of a tunnel

As all works, a tunnel must be inspected to prevent repairs. In this part of DIDACTU we present the different operations that tunnel operators use to do for the benefit of the users: inventory or fixtures, improvement, maintenance and restoration.

5 COMPARISON OR PARAMETRIC STUDY

With DIDACTU, it's very easy to compute the same case with several methods or for different geotechnical parameters and to discover the change in the result following the hypothesis hidden in each method. This approach

is very useful when teaching, as it supports the comprehension of the theories.

6 SOME WORDS ON DIDACPENTE

Founded on the same principles than DIDACTU, DIDACPENTE proposes to the users the bases needed for understanding and study of a problem of slope stability. Software allows estimation of stability for simple situation but also with nailing reinforcement and use of geosynthetics. This tool boards also the segmental retaining walls reinforced with geosynthetics. DIDACPENTE is a receptacle of news ideas as study of creep of reinforced massif by geotextile or as study of slope displacement in relation with pluviometry.

DIDACPENTE presents too transversal studies as record as use of geotextile or some particular studies as the comparison of calculation in the 19th century of the Channels of Panama and Burgundy.

7 CONCLUSION

The whole world of tunnel or landslides is not yet in DIDACTU or DIDACPENTE and certainly will never be. But we can improve it, by development of that is already coded and by addition of new topics. We hope that we can find help from students but also from companies that have lot of pictures and interesting references. The two tools are also appreciated supports for different teaching in universities or continued formation. They are on Internet site: www.pentes-tunnels.eu

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