On-line Interactive Digital Resources for Soil and Rock Mechanics Lab Practices Teaching and Learning on Erasmus Mundus Masters Programmes

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Abstract

In this paper, a methodology based on the use of on-line digital resources for teaching soil and rock mechanics laboratory practices on Erasmus Mundus Masters is presented. The proposed resources allow the students to view the complete realization of laboratory tests.Some of these tests can even last more than a week and cannot be fully performed during teaching hours. As a consequence, the presented resourcesare a complementary, detailed and flexible way to fully study the different laboratory procedures.

Keywords: on-line resources, soil mechanics, rock mechanics, Erasmus Mundus Masters

1. Introduction

Information and communication technologies are rightly recognized as tools that are radically transforming the process of learning and becoming one of the most popular solutions to meet students need [1].The emergence of technologies such as Internet provides the possibility of perform decentralized laboratory practices, in flexible schedules and from geographically very dispersed locations that can be easily incorporated to e-learning systems [2]. In our case, soil and rock mechanic (SARM) tests performed during laboratory practices on Erasmus Mundus Masters are usually developed by a laboratory technician with the support of the teacher's oral explanations. Consequently, the interaction of the students with the tests performance is usually low, limited to viewing the performance of standardized procedures and notestakenof the tests partial values for the further development of their laboratory reports. Furthermore, most of the tests require several days (even weeks) for completion and as a consequence, it is unfeasible to fully complete the tests in one lab session. For a better understanding of the lab test procedures on-line resources have been developed.

Although a wide number of geotechnical engineering resources are available on Internet [3], in this paper we describe*ad hoc* technological resources for SARM lab practices available for the students, which provide an orderly and detailed implementation of the different geotechnical standardized tests of the SARM labs.

Thus,the proposed resources allow students to perform the lab practices from anywhere, as often as required, manage the display of the different tests procedures and even perform a continuous and accelerated view of long duration tests.

2. Motivation and objectives

The preparation of these on-line resources was mainly motivated by the reasons listed below:

- The short time available for the development of the laboratory practices of SARM lab practices only allows showing the general and conceptual aspects of the more relevant and common geotechnical tests to the students.
- They allow to recover the laboratory practices for those students that, for different reasons, were not able to attend the practices in the official set dates due to the rigidity of schedules and the assignment of the students to specific groups.
- The impossibility of individuals toprepare and perform the geotechnical tests mainly due to the need for prior formation and training for performing such test.
- Most of the laboratory geotechnical tests last more than 24 hours and as a consequence it is not possible to fully develop the laboratory test in only one session. Moreover, there are several laboratory tests (e.g. standard oedometer test, etc.) whose duration is even longer than one week.

The main objectives to be achieved with the development of the virtual practices are:

- To provide a common on-line platform where students can find a wide number of digital resources.
- To put into practice the knowledge acquired in the theoretical part of the course.
- To better understand complex geotechnical phenomena.
- To familiarize students with the laboratory instruments (e.g. linear variable differential transformer – LVDT-, load cell, manometer, etc.) which are used for measuring different variables (e.g. displacements, forces, pressures, etc.).
- To introduce students to the procedures for conducting the different laboratory tests.
- To flexibly perform/follow (from anywhere and at any time) laboratory practices through Internet
- To entirely view the development of long-term geotechnical tests, that cannot be fully developed during a conventional laboratory practice session.
- To provide the students the necessary knowledge on how to calculate the geotechnical parameters derived from different tests (e.g. angle of friction, coefficient of consolidation, point-load strength, etc.).

So, the e-learning possibilities provided by new technologies for developing remote and non-attendance Soil and Rock mechanics labs are a huge organizational advantage for students and furthermore they contribute to an efficient learning of the test procedures. Therefore, this paper outlines the proposed educational resources for developing the geotechnical laboratory practices of different subjects ofSARM.

3. Methodology

In order to archive the previously mentioned objectives, four main types of digital resources have been prepared. The first one consists ofAdobe Flash Player

animations which describe the different tests procedures (Figure 1). These resources have been prepared for each different test (e.g. triaxial test, oedometric test, slake durability test, etc.) following standards and are composed of next sections: title page, equipment required for the test, normalized testing procedure and the calculation of results. These animations contain photographs, conceptual schemes, detail general pictures and explanatory text for a full understanding of the test procedures, their purpose and their interpretation.

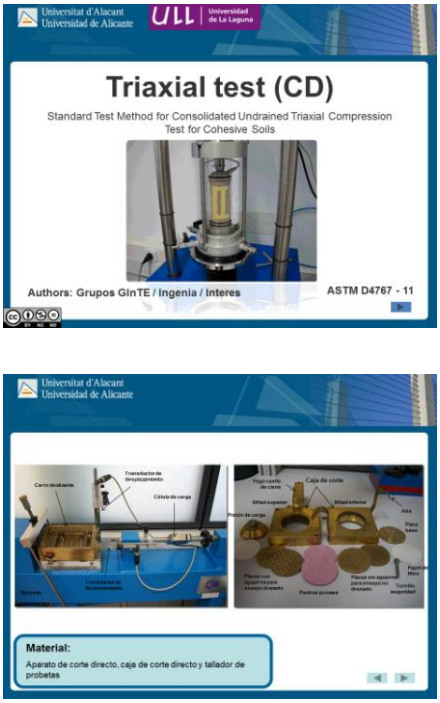

Fig. 1: (Above) Title page of the laboratory practice for the triaxial test. (Below) Apparatus section of the direct shear test.

Secondly, digital videos of geotechnical tests have been recordedand edited (Figure 2). The elaborated videos complement the Adobe® Flash® Player resources, providing a dynamic image and an audio description of tests procedures. A voiceover describes in detail the different stages of test procedures. The videos are complemented by audio explanations about how to compute the different geotechnical parameter from the performed tests and by conceptual explanations.

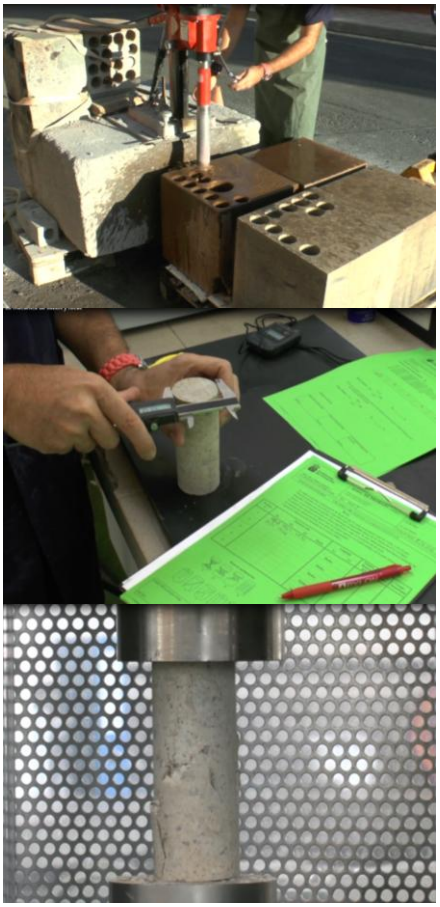

Fig. 2: Frames sequence of the movie corresponding to uniaxial compressive strength of the intact rock.

Thirdly, different Excel® worksheets have been specifically developed for the analysis and interpretation of the test results (e.g. for the determination of the elastic settlement under flexible footings). These worksheets are intuitive and easy to be used. Furthermore, they can be edited by the students in order to fit their needs.

Finally, in the web platform the students also can find links to several free software (e.g. Stereo32,a program to display and evaluate discontinuity data in rock mechanics).
Additionally, a broad number of technical regulations on digital format, webpage links, other geotechnical on-line videos from YouTube™, etc. are available for students on the web platform.
All this digital resources can be freely downloaded from the web platform from the GInTE [4] providing a very useful complementary tool for a whole understanding of geotechnical concepts and laboratory standard procedures, concept and interpretation.

4. Conclusions

In this work virtual resources for soil and rock mechanics laboratory practices of Erasmus Mundus Masters are presented. These resources will allow the students to perform a more efficient virtuallearning (also called e-learning).
The proposed individual and remote methodology using a web platform will be very useful for complementing the theory sessions developed by the teacher. Furthermore this methodology will allow the student to perform the laboratory practices remotely (e.g. from home) and repeatedly (as often as required or desired) and also will allow them to know the apparatus and the equipment required by the tests, the sample preparation, the test procedures (even for long-term tests) and the interpretation and representation of the results. A remarkable advantage is that the whole number of available resources (Adobe® Flash® Player animations, digital videos, Excel® worksheets and other additional resources) are available in a unique place which can be frequently and easily updated.

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6. References

[1] S.Campanella,G.Dimauro, A.Ferrante, D. Impedovo, S.Impedovo, M.G.Lucchese,R. Modugno, , G.Pirlo, L.Sarcinella, E. Stasolla and C. A.Trullo, “Engineering e-learning surveys: a new approach”. *International journal of education and information technologies*, 1, 127-135, 2007.

[2] M.L.Martínez, J. Fédez and G. Romero, “WEB3D graphics in the WEBD Project: new trend in a collaborative environment”. *Int. Workshop on “New WEB technologies for collaborative design, learning and training*, Nov. 2003, Turín (Italia), 2003.

[3] A.Chegenizadeh and Hamid Nikraz, “Review on WEB Resources in Teaching of Geotechnical Engineering”, *World Academy of Science, Engineering and Technology*, 66, 255-257, 2012.

[4] Grupo de Innovación Tecnológico-Educativa de Ingeniería del Terreno (GInTE), http://web.ua.es/es/ginter/.