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SEISMOCODE: online instructional platform for the professional upgrading of structural design engineers

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***Abstract**: In a country like Romania, where about two-thirds of the territory is affected periodically by strong earthquakes, the proper design of buildings to seismic actions is an essential prerequisite for the safety of the population. Structural engineers are responsible for taking appropriate measures in the design of buildings, so that these will not collapse in future earthquakes. This is accomplished by an intricate and laborious process, for which seismic codes provide the necessary rules and procedures. With the accession of Romania to the EU, the country has adopted several European standards and regulations, which have replaced or completed the national regulatory body. At the same time, national codes were harmonized with European standards, in the framework of a countrywide programme that started in the early '90s. The current Romanian code for the design of buildings for earthquake resistance, P100-1/2013, represents an improved version of the first European harmonized seismic code, P100-1/2006. Due to their increased complexity and novelty, the application of these codes in the design of buildings represents a significant challenge for the professional community. Practically all structural engineers more than 32 years old in the country were taught seismic design according to older codes. Several initiatives were taken for their professional upgrading, in which universities and professional associations were involved. However, the impact of these initiatives is still very low. An online platform for the instruction of structural design engineers in the use of the new seismic design code, based on the Moodle platform, is presently developed by the authors, in the framework of a complex research project, involving a consortium of three institutions: a university, a research institute and an IT organization. The platform will consist of a body of knowledge, supplemented with related wiki sections. Exercises, tests and quizzes will be included, to facilitate learning. A collection of multimedia resources, with video presentations of renowned specialists will be also available to users. Feedback from the professional community and from prospective users will be collected by questionnaires available on the platform. A forum will be also configured, to allow user interaction.*

***Keywords:** life-long learning; e-learning; seismic codes; building design; engineering education*

I. INTRODUCTION

About two-thirds of the territory of Romania is affected periodically by strong earthquakes, most of them generated by the Vrancea seismic source. Additionally, other seismic sources, located in various areas of the country, generate earthquakes that along the history have also generated important losses. Under these circumstances, a proper seismic design of buildings represents an essential prerequisite for the safety of the population. Structural engineers are responsible for taking appropriate measures in the design of buildings, so that these will not collapse in future earthquakes. This is accomplished by an intricate and laborious process, for which seismic codes provide the necessary rules and procedures.

The accession of Romania to the European Union represented a turning point not only for the general evolution of the country, but also triggered an important revision process for the regulatory body. The country has adopted several European standards and regulations replacing or completing their national homologues. National codes were harmonized with European standards, in the framework of a countrywide programme that was launched in the early '90s.

Enforced starting from 2014, the current Romanian code for the design of buildings for earthquake resistance, P100-1/2013 [1], brings several improvements to the first European harmonized seismic code, P100-1/2006 [2]. Due to the increased complexity and novelty of these two code releases, their application in the design of buildings represents today a significant challenge for the professional community. Practically all structural engineers more than 32 years old in the country were taught seismic design according to older codes during their university studies.

Several initiatives were taken for the professional upgrading of Romanian structural engineers, in which the Technical University of Civil Engineering in Bucharest and professional associations, as the Association of Structural Design Engineers, AICPS, were involved. However, the impact of these initiatives is still deemed insufficient by the stakeholders.

II. THE SEISMOCODE PLATFORM

2.1 Structure and objectives

The national research and development project SEISMOCODE, carried on under the authority and partly funded by the Scientific Research, Executive Agency for Higher Education, Research, Development and Innovation (UEFISCDI) in Romania, was launched in 2014. The project aims to develop an online platform for the instruction of structural design engineers in the practical application of the new seismic design code. The project consortium is formed by three organizations: the Technical University of Civil Engineering Bucharest, the National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development "URBAN-INCERC" and the Institute for Computers, ITC S.A., in Bucharest, the last organization being a co-funding partner. SEISMOCODE benefits from the experience of the involved teams in the development of seismic design regulations and in the development of e-learning platforms and applications.

The objectives of the project are to:

- develop a complex e-learning platform to support the active implementation of the newly-adopted Romanian code for the design of buildings for earthquake resistance, P100-1/2013, harmonized with the homologous European standard, Eurocode 8, part 1 (EN 1998-1:2004) [3];
- create a systematic and structured online body of engineering knowledge in the field of seismic conception and design of buildings, which platform users can continuously develop by their own contributions;
- develop a set of interactive e-learning modules for the improvement and (self-) evaluation of knowledge, facilitating the assimilation of new regulations
- create a repository of multimedia resources in the field of modern seismic conception and design of buildings;
- provide a virtual space for professional discussions on the present and future development and improvement of regulations concerning seismic design and seismic risk reduction of

buildings; this space will be also an important channel for interacting with platform users and with other stakeholders.

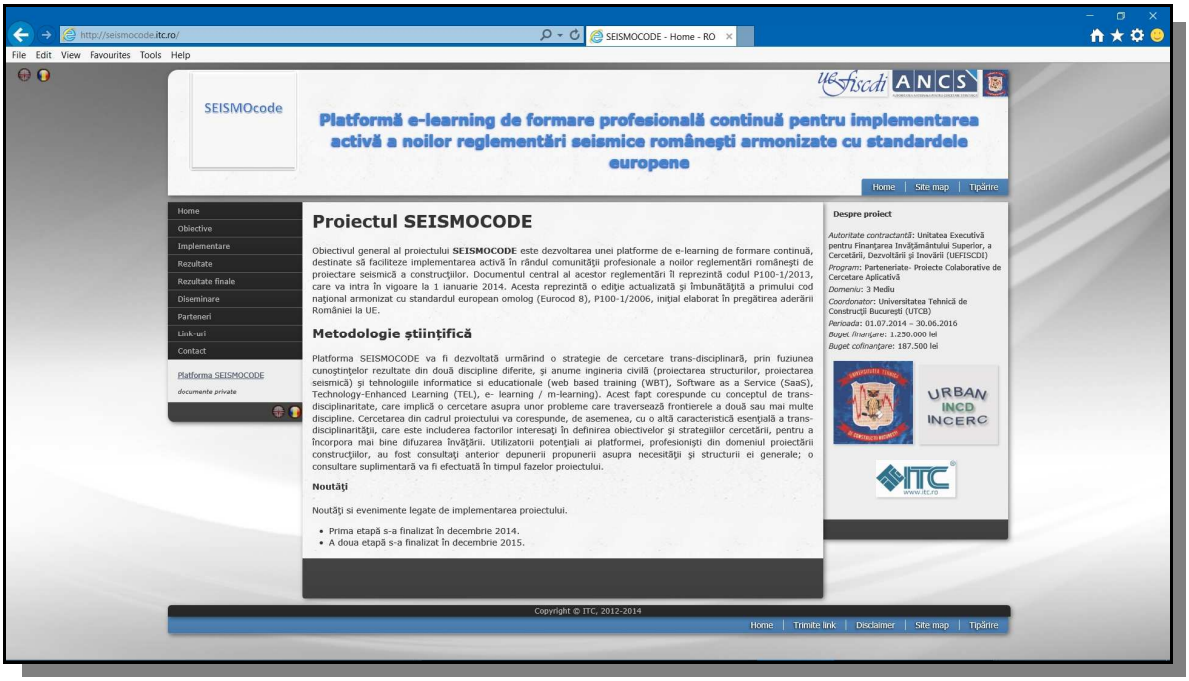


Fig. 1. Home page of SEISMOCODE project website [4]

The platform will consist of:

- a *Body of Knowledge* (BK), supplemented with related *Wiki* sections (WS);
- exercises, tests and quizzes, aimed to facilitate learning, implementing the *Interactive E-Learning Modules* (IELM);
- a collection of *Multimedia Resources* (MR), with video presentations of renowned specialists in the field of the seismic design of buildings;
- online questionnaires, to collect feedback from the professional community and from prospective users;
- a discussion forum, to allow for user interaction.

The above objectives and outcomes are meant to fill the gaps identified by a comprehensive analysis of the situation in the field of the project, performed by the authors of the proposal in recent years, and based on their direct involvement in activities such as development, validation, analysis, application or dissemination of the new regulations. The addressed needs were also determined by the authors during their current activity, as well as from the interaction with civil engineering professionals, or from the debates occasioned by major events of the profession.

Additional details on the regulatory basis, global structure and intended outcomes of the SEISMOCODE platform are given in [5] and [6].

2.2 Software implementation

Moodle [7] is one of the most popular web-based *Learning Management Systems* (LSM) and the most employed e-learning platforms in Romania. Its main characteristics are configurability and modularity, as suggested also by Moodle acronym – *Modular Object-Oriented Dynamic Learning Environment*. Apart from other known LMS, Moodle is also a free and open-source software application, well documented and with an active community.

Data from the Moodle organization web site [8] show that in Romania are implemented 231 Moodle registered sites, as compared to 1267 in Poland, 1136 in Portugal and 3343 in the United Kingdom. The most prominent implementations in Romania consist of virtual campuses, such as "Vasile Goldis" Western University of Arad, with two websites, one for courses and one for examinations [9][10], "Transilvania" University of Brasov [11], Agora University of Oradea [12] or "Victor Babes" University of Medicine and Pharmacy Timisoara [13], which offer full e-learning

systems, i.e. for teaching, learning and assessment. Platforms dedicated to a specific learning topic, such as informatics, economy, and statistics, available within schools or provided by private lecturers, are also implemented.

For the SEISMOCODE project, Moodle was the LMS of choice for the implementation of the professional lifelong e-learning platform [14]. The development of the platform content was performed in correlation with the capabilities of this product, in order to achieve a seamless integration and an optimal benefit from the rich Moodle features, supporting teaching, learning, self-assessment, collaborative work, social community.

The architecture of the Moodle installation includes a Microsoft Windows Server 2008 R2, Microsoft Internet Information Server (IIS) as the web server, the PHP plugin and the default MySQL backend database. The whole system is hosted and administered by Institute for Computers (ITC), a partner in the SEISMOCODE project, which also provides the internet services. For the present implementation stage, a few generic accounts where created, featuring the roles of administrator, teacher and student.

2.3 Current state of the platform

The SEISMOCODE life-long learning platform is developed as a system of interconnected modules, using the facilities provided by Moodle. In the current stage, the development of the structure and of the content of the Body of Knowledge was initiated, as well as of the structure of the Wiki System.

According to the objectives of the project, the Body of Knowledge (BK) contains the basic hypertext and illustrative material, structured according to the logic flowcharts of seismic design procedures. The BK content is implemented by using the *Courses* feature of the Moodle platform.

The Wiki System (WS) is interconnected with BK, bringing in additional information. WS is conceived as a more flexible component of the platform, as compared to BK, allowing the gradual development of knowledge accumulated in the platform, by successively adding articles written by the members of the project team or by other specialists.

In addition to the two major components above, other useful components were initiated, using specific features of the Moodle platform. Thus, the platform includes at present:

- a general and a specific glossary (with the *Glossary* feature);
- exemplifications for the various sections of BK (using the *Page* feature);
- short explanations inserted in the text (with the *Label* feature);
- keywords (using the *Tags* feature).

Some other Moodle features were tested, in order to allow choosing the best solutions in the subsequent phases of the project.

A simple and schematic layout of the pages, optimized for clarity, was used. Important notions and keywords were highlighted with different font. Bulleted lists were preferred to compact blocks of text whenever appropriate.

Given the scope and destination of the SEISMOCODE platform, i.e. the life-long professional training of building design engineers in the application of the new Romanian seismic code, one of the most important components of the platform is the Body of Knowledge. This is conceived as the main documentary resource, providing explanations focused on specific issues. A special attention is given to the aspects identified by the civil engineering members of the project team as being more difficult to assimilate. Here, the advantage of these members of being continuously in contact with students and graduates, structural engineering professionals and the civil engineering community in general is fully fructified.

For a systematic approach, the Body of Knowledge is structured according to a treelike scheme, following, as closely as possible, the logical flow of seismic design procedures. Every content unit includes references to the relevant provisions of the Romanian codes and standards and, if appropriate, also to the Eurocodes. These last were adopted as Romanian standards, to each being added a National Annex, containing specific provisions for Romania.

The implemented sections of the Body of Knowledge are currently the following:

1. *General aspects*
2. *Performance demands for the structure of a building subjected to seismic loads*
3. *Selection of structural system and establishment of structural configuration*

4. *Establishment of the energy dissipation mechanism and of the ductility level*
5. *Assessment of non-seismic loads and of masses*
6. *Assessment of seismic design loads*
7. *Pre-dimensioning of structural members*
8. *Structural modeling and analysis*
9. *Dimensioning and verification of structural members and of entire structure*
10. *Frame structures*
11. *Dual structures*
12. *Analysis and detailing of floor slabs as horizontal diaphragms*
13. *Dimensioning of the infrastructure*
14. *Nonlinear static analysis*
15. *Nonlinear dynamic analysis*

The sections and subsections of the Body of Knowledge are completed with various Wiki pages, examples, glossaries, tags and labels that facilitate the understanding of the basic content.

Some screenshots of the SEISMOCODE platform are presented in the following.

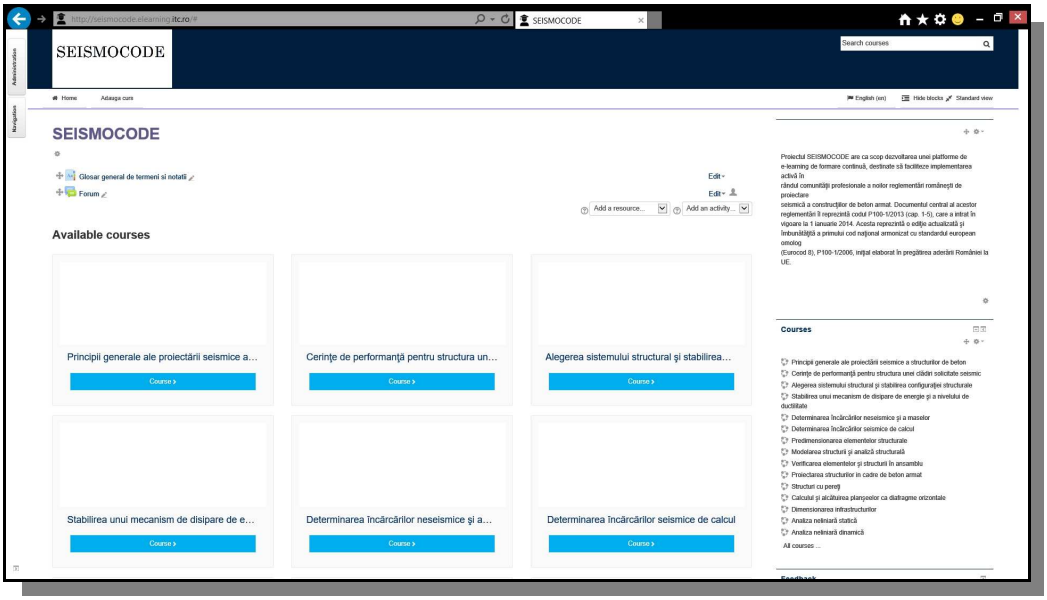


Fig. 2. Main page with course list

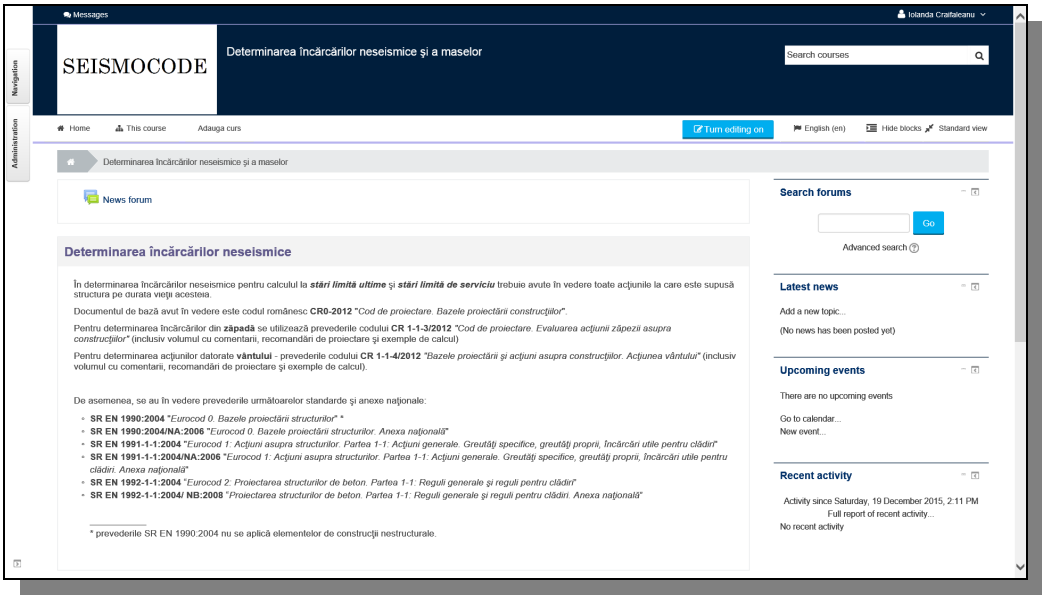


Fig. 3. Typical course format

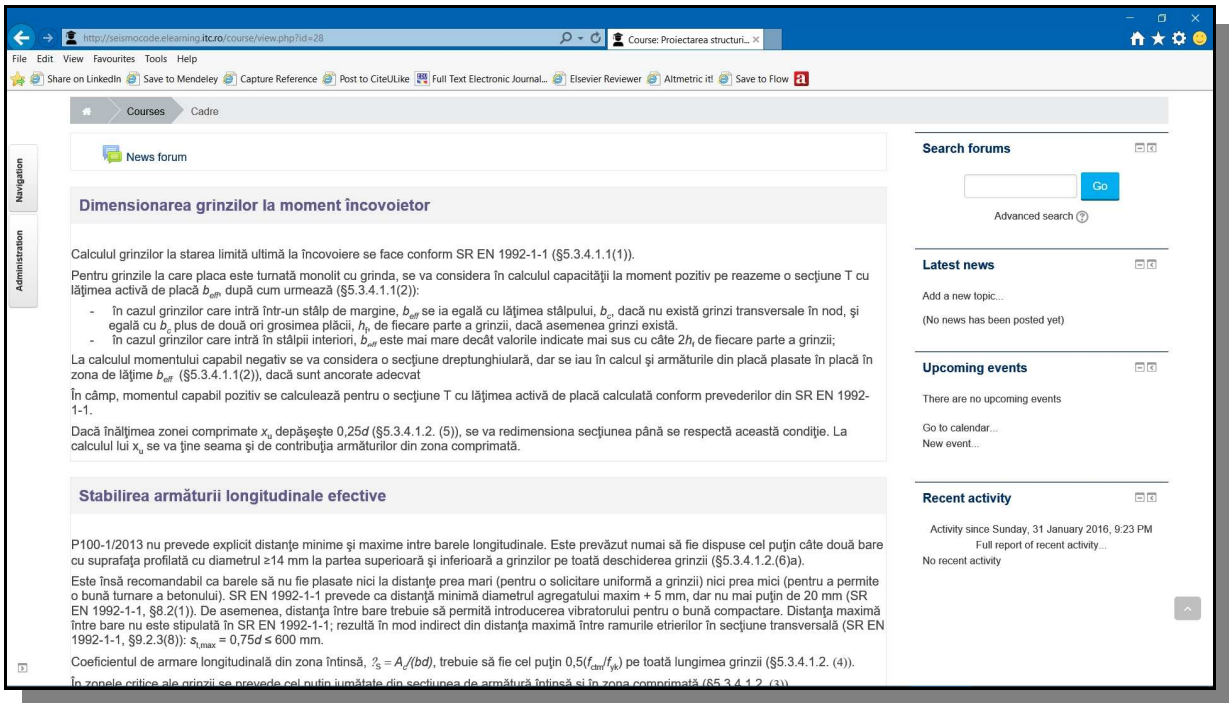
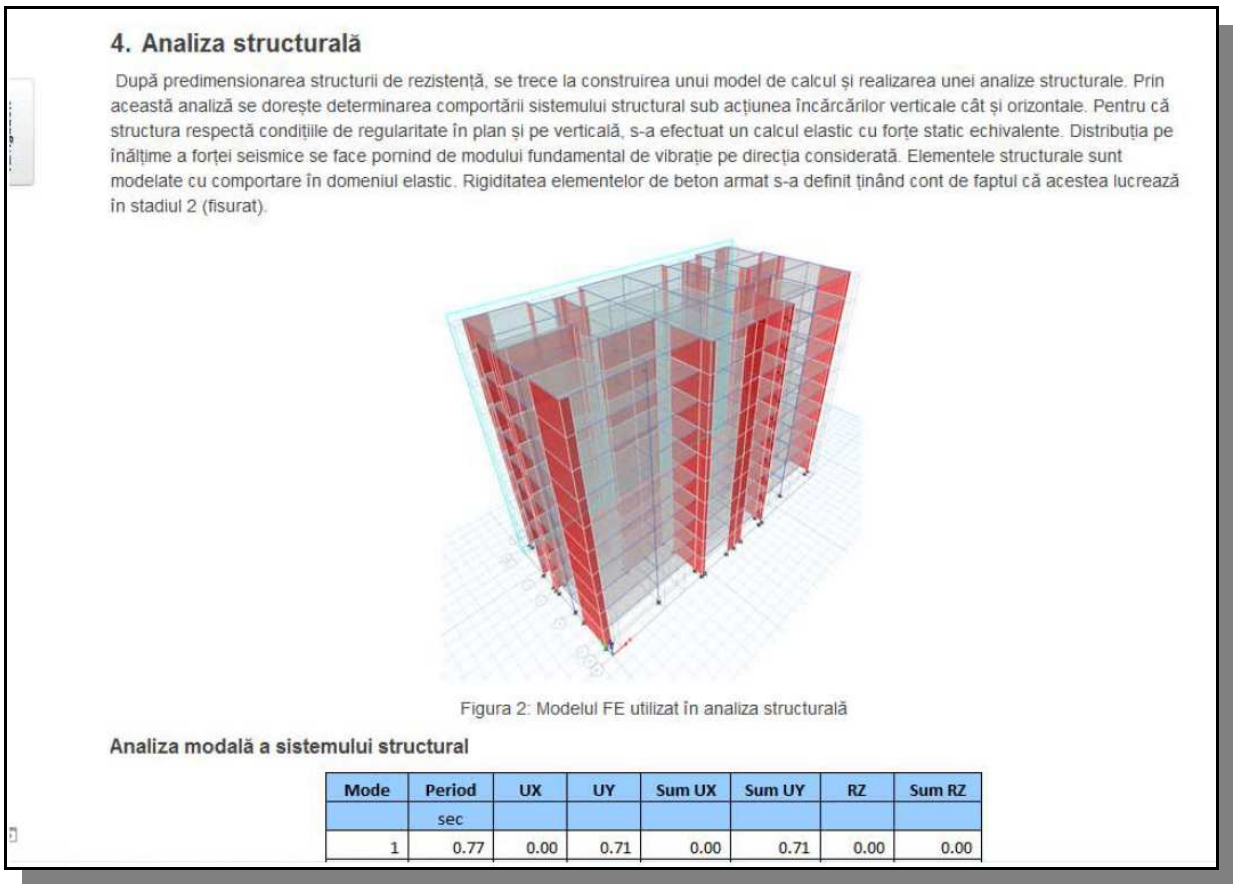


Fig. 4. Structuring of course information



Mode	Period	UX	UY	Sum UX	Sum UY	RZ	Sum RZ
	sec						
1	0.77	0.00	0.71	0.00	0.71	0.00	0.00

Fig. 5. Illustrative building model for structural analysis

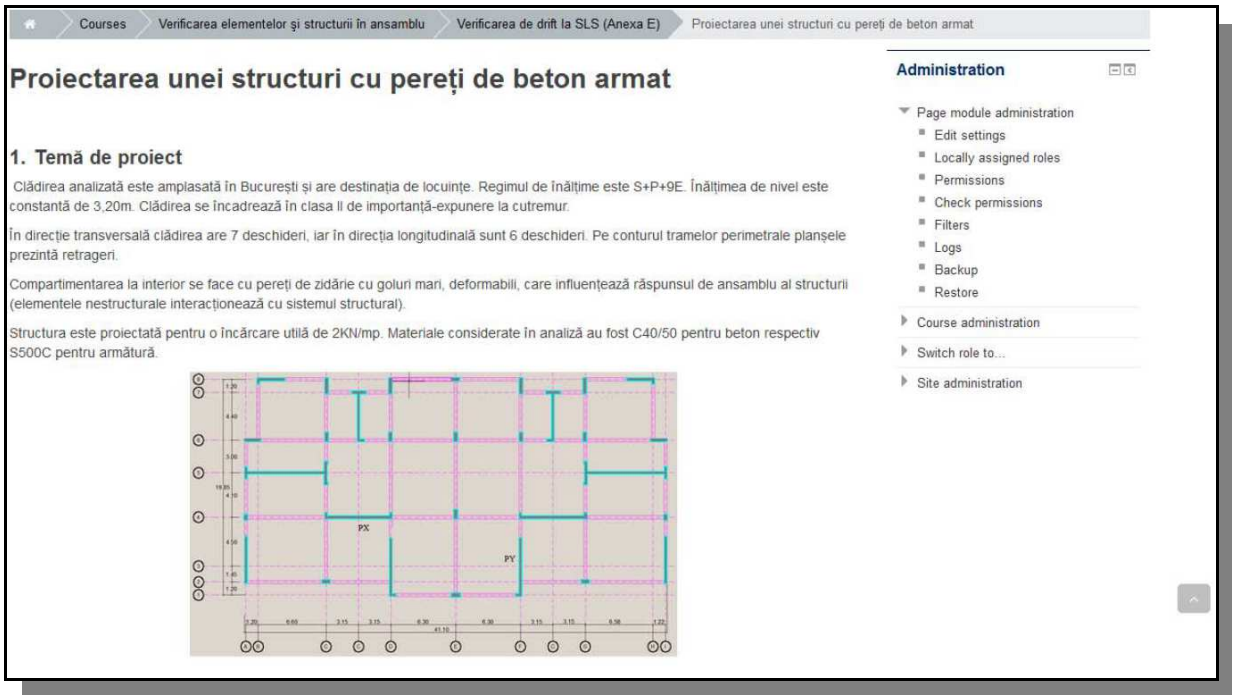


Fig. 6. Example – design of a reinforced concrete shear wall structure

III. CONCLUSIONS

The SEISMOCODE lifelong e-learning platform is developed in support to the assimilation by the professional community of structural design engineers of the new European harmonized Romanian seismic design code. The platform is implemented using Moodle and combines the various capabilities of this product to obtain an optimal efficiency of the learning process.

Some of the main features of the platform were presented, as well as the concepts and methods used in its development.

The platform is conceived in support to professional post-graduate and lifelong learning programs conducted by accredited organizations and Romanian national authorities. In addition, SEISMOCODE could represent, after its completion, a valuable teaching resource for graduate and post-graduate university programs.

Acknowledgements

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