Education and practice: The Peruvian experience

Education et pratique: une experience péruvienne

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ABSTRACT

This paper describes the Peruvian experience which proposed a change in the curricula of the career of Civil Engineering at the Ricardo Palma University from Lima, Peru. With a more special focus on the teaching-learning of Geotechnical Engineering by the development of field survey workshops and seminars with the students of Engineering Foundations and Geotechnical Design. The experience focused in the Geotechnical Design and effective field practice, workgroups development, organizational maintenance and oral and written communication skills as well as in the application of the Geotechnical Engineering in the seismic prevention and geotechnical risk. This experience was carried out on the popular human settlements of Metropolitan Lima, where the effects of an earthquake with Magnitude 8.7 (Mw) or higher, would originate a very considerable amount of human and economical losses. This paper summarizes some important surveys accomplished by the students, which show precarious foundations due to poor technical and professional knowledge on loose granular soils, non compacted landfills and soft geotechnical materials. Finally, this paper discusses the on-going research about these precarious foundations on loose materials made of original rocks from the site, called "pircas".

RÉSUMÉ

Cet article décrit l´expérience Péruvienne la quelle propose une modification de la formation professionnelle d'un ingénieur civil péruvien à l'Université Ricardo Palma de Lima, Pérou et plus particulièrement concernant l'enseignement formation dans le domaine de l'ingénierie Géotechnique. Ceci s´est fait grâce au développement d'ateliers de relevés sur site, séminaires et cours théoriques avec les étudiants des cours d´Ingénierie de Fondation y Design Géotechnique. Cette expérience était basée sur la pratique sur site, déroulement des groupes de travaille, la gestion de l´organisation et développement de la communication orale et écrite et. Le but était de pouvoir remarquer le Design Géotechnique lors d´une expérience qui se focalisait sur l´application de l´ Ingénierie Géotechnique. Tous les résultats de cette expérience furent possibles par des études et travaux réalisés par les étudiants de université dans des cartiers populaires de Lima Capitale. Les investigations sont issues des lieux oú les sols sont granulaire souples, remblayés non compactés oú bien matériaux géotechniques faibles ou toutes les maisons sont construites et cimentées sans aucune assistance technique ou professionnelle. Les études dans cettes zones permettent l´application de l'Ingénierie Géotechnique dans la prévention sismique et le risque géotechnique car dans un cas d´un séisme de 8.7Mw a plus on aurait des nombreuses pertes humaines et économiques. Ensuite est commentée et analysé les résultats des investigations et leurs solutions possibles pour les fondations basées sur des matériaux souples faites par l´enrochement de la même zone apellées "pircas".

Keywords : education, teaching geotechnical, case study, foundations

1 INTRODUCTION

There are many studies about the interaction between educational and professional practice on geotechnical engineering, however, many failures on methodologies have been identified. In Peru, two universities implemented good methodologies for the last 12 years with successful results.

This new approach started in the course of Advance Foundations at the *National University of Engineering from Peru,* in 1964, and it was continued at the *Ricardo Palma University*. After a conceptual introduction review, real engineering problems are discussed where a failure mechanism is described, shown, and analyzed in order to come out with conclusions and recommendations.

Then, students are encouraged to propose additional solutions that could improve the ones proposed in the class. The author has found that many of the recommendations made by the students are very important and useful.

In addition, student groups are formed for field work during the semester. Field works include penetration testing with light equipment, shallow soil sampling, and geotechnical work & analysis on laboratory. At the end, the students prepare a report with all the necessary documentation.

2 CHANGE ADAPTATION

Education is an interactive process among different individuals with different interests and goals. In the engineering education, the communication and the active participation on practical areas can be more important than theoretical acknowledges throughout traditional classes. Professors and students must have a constant interaction in order to establish correlations with the theory and the field practice. Due to that premise, the Ricardo Palma University from Peru has implemented changes in the geotechnical engineering traditional teaching.

The author has many years of experience in the academic area. He has come to the conclusion that if the students have a clear understanding of the geotechnical practical principles and methods with the theoretical concepts, the learning of this discipline will be more effective. This can be achieved by stimulating research and communicating with a professor that have professional experience as well.

In their classes of foundations and geotechnical design, the author has implanted changes that created field work groups, leadership development, and communication skills for engineering students in order to become more successful in resolving real engineering problems. It is up to the professor to stimulate initiatives that will enforce the abilities of their students.

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3 SEISMICITY IN THE STUDY AREA

Seismicity in Peru is due to events produced by the plates subduction, as a result of the rupture of the area where the Nazca and Continental plates converges, creating interplate and intraplate earthquakes. (Figures 1, 2 and 3).

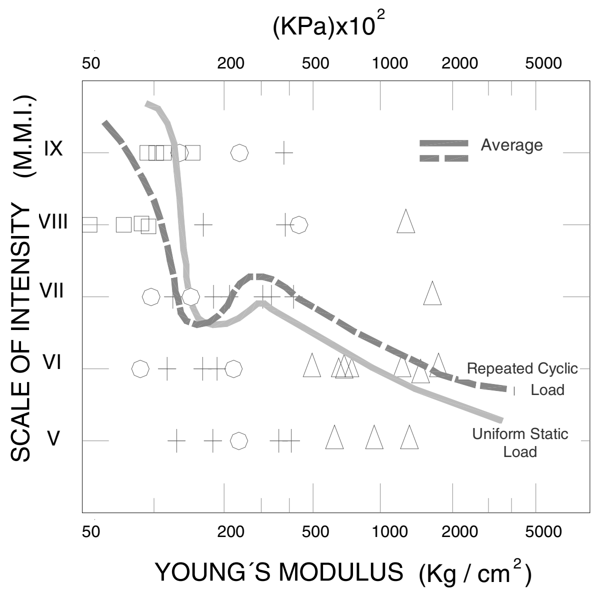

Figure 1. Elastic modulus and intensity Scale, Lima Earthquake, 1974


Figure 2. Earthquake Damages Pisco, Peru, August 2007

From the deterministic calculations, the most critic maximum credible event seems to be associated with the interplate subduction events. Those events have an interval recurrence of a century.

Peru is prone to suffer an event like this in a nearby future and its magnitude ranges from 8.0Mw to 8.8Mw and with a peak horizontal acceleration that ranges from 0.15g to 0.45g (even more sometimes).

Because of this, it is very important to develop a serious program of seismic prevention in the most critical places where approximately five thousands indigent families live who can not afford the construction of safe households.

4 EDUCATION AND PRACTICE

Considering the Peruvian seismological reality and proposing a change in the University curricula, the author created a research student workshop that enables the application of soil mechanics and foundation engineering in combination with field work as well as to develop programs to teach the settlers how to build their constructions. The field work results allow us to establish geotechnical parameters and to provide user-friendly information in regards to safety guidelines during an earthquake event.


Figure 3. Earthquake Total Destruction Pisco, August 2007

The workshop gave satisfactory results because students perform their own field exploration, have a strong knowledge of the site condition of soils, and are able to do an interpretation of their behavior. Finally, students are able to give diagnostic and prediction of failure due to seismic effects on the existing foundations.

In the workshops, passive students could express their own opinions, go to the field, and execute a “test-hole” in a particular soil. Finally, they prepared a well documented engineering report.

This project continues to look for practical solutions with the cooperation of the private sector. Initially, it was considered the households from a group of settlers that has high risk unstable foundations. These precarious footings are built from sharp stones without any void filling material. These stones form a staggered terrace on the slope of the mountain called “pircas”. This type of construction is too heavy and in a severe earthquake event, it will fail resulting in construction damages and human losses (Figure 4).


Figure 4. Placement of households with unstable foundations

5 FOUNDATIONS ON PIRCAS AND NON COMPACTED FILLS

With field explorations and the obtained information from surveys made by the students, many places were identified where common construction of "pircas" were used. A model was developed in order to analyze their static and seismic conditions, considering the earthquake magnitude according to the site seismic recurrence and building characteristics as well as their risk and vulnerability due to more common disasters (Figure 5, and 6).

Figure 5. Failure on continuous footing supported on "Pircas"

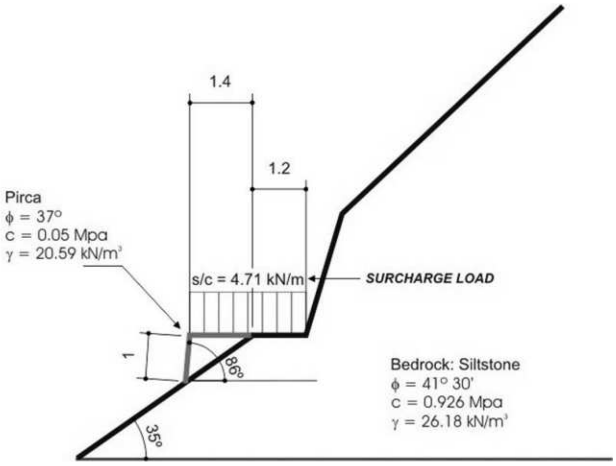

Figure 6. Geotechnical Model of the Problem. "Pirca"

Figure 7. Typical Foundations on "Pircas"

A typical case of slope failure was considered in order to determine through back analysis and test in situ (Figure 7), the resistance average parameters to shear strength. Data was evaluated on laboratory, in a real scale prototype with the geotechnical site conditions. In addition, geological characteristics of the site were also considered.

The results show safety factors that are lower than 1, and significantly lower in case of an earthquake of shallow acceleration of 0.30g and magnitude of 7.5Mw (Table 1), values which point out that it is not necessary an earthquake to cause slides on the foundation. Because of these results, it is essential to check for practical and economical solutions in order to avoid material and human losses (Figures 8). The progress of these studies allows us to establish the construction process in walls, platforms, and foundations.

The project continuation is in charge of graduate professors and students from the Civil Engineering Department at the Ricardo Palma University from Peru.

Table 1

Factor of Safety / Method	Condition	
	Static	Seismic
Slide 5.0	0.913	0.755
Slope/W	0.847	0.712
McStar 2000	0.911	0.701

Figure 8. Staggered Terraces built with "Pircas"

6 CONCLUSIONS

In this Peruvian experience, the most important achieved goal was to compromise students not only with field work but also with social work for the settlers that are in need of practical and economical information for building their homes. At the same time, private firms got involve in this process offering their support and help for future research.

It was established that the lack of prevention makes its own spread out more necessary. At the end, this Peruvian experience yields results which are technically, socially, and academically satisfactory, in favor of the most needed settlers of the metropolis, who inhabits on high seismic risk zones; given the fact that not just the behavior of the supporting soil or the slope instability of the "pircas" problem have been studied, but either labors of seismic prevention have been performed, show them how to act in order to save their lives on the case an severe event could occur in the future.

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