SEISMIC SOIL CLASS ACCORDING TO EUROPEAN AND ITALIAN CODES MAP FOR ITALY

G. Forte[1], E. Chioccarelli[2], M. De Falco[1], P. Cito[3], A. Santo[1], I. Iervolino[3]
[1] *DICEA, Dipartimento d'Ingegneria Civile, Edile ed Ambientale, Università degli Studi di Napoli Federico II, Italy*
[2] *Università Telematica Pegaso, Italy*
[3] *DIST, Dipartimento di Strutture per l'Ingegneria e l'Architettura, Università degli Studi di Napoli Federico II, Italy*

Soil conditions affect ground motion amplification. Thus, seismic site classification is a critical issue to predict ground motion parameters in the context of both probabilistic seismic hazard analysis and real-time generation of shaking maps. Especially on large areas, simplified procedures for estimating the seismic soil amplification can be advantageous. In order to account for these local effects, some proxies which account for the soil behaviour can be identified; e.g., the average shear-wave velocity of the upper 30 m ($V_{S,30}$), or the equivalent shear-wave velocity from the depth of the seismic bedrock ($V_{S,eq}$).

In this study, two maps of seismic shallow soil classification for Italy according to Eurocode 8 (EC08) and the new Italian Building Code (ItBC2018) are presented. The methodology from which the maps are derived is described in Forte *et al.* (2019) and accounts for two sources of information: site-specific measurements and large-scale geological maps. The soil maps are obtained via a four-step procedure:

(1) a database of about four-thousand shear-waves velocity (Vs) measurements coming from in-hole tests, surface geophysical tests and microtremors is built, covering (unevenly) the whole national territory;
(2) twenty geo-lithological complexes are identified from the available geological maps;
(3) the investigations are grouped as a function of the geo-lithological complex and the distribution of measured $V_{S,30}$, $V_{S,eq}$ are derived;
(4) medians and standard deviations of such distributions are assumed to be representative of the corresponding complexes that are consequently associated to soil classes.

The seismic soil map for EC08 resulted to be mainly made of B class (around 58%), followed by C (around 20%). The soil class A is (around 19% of sites), D is the less represented class (around 4%). The seismic soil class map for ItBC2018 reports similar results; in particular, the A class is represented by 13% of sites, B is again the most representative with 56%, C and D class are characterized by the same values of 20% and 4% of sites. For this classification, E class is also introduced and resulted in the 7% of sites.

To make the results of the study available, a stand-alone software **"SSC-Italy"** has been developed and is freely available at http://wpage. unina.it/iuniervo/SSC-Italy.zip. The user is first required to select the reference code; i.e. EC8 or ItBC2018. Then, the coordinates of the site(s) can be defined. For each selected site, SSC-Italy provides the soil class together with the median(s) and the standard deviation(s) and a map of the corresponding soil classes around a neighbourhood of about one hundred kilometres.

The results of PSHA on a national scale in terms of peak ground acceleration (PGA) for an exceedance return period equal to 475 years can be organized in in four classes of seismicity, between 0 and 0.1 g, 0.1 g and 0.2 g, 0.2 g and 0.3 g, 0.3 g and 0.4 g. Assuming rock sites, the first and second classes are 33.2% and 48.7%, the third is 18.1%, while the last (0.3 -0.4 g) is not represented, due to a maximum value PGA of 0.27g. The same calculations adopting soil conditions identify a reduction of the first and second class with values of 23.2% and 37.4%, respectively. The sites with PGA in the range between 0.2 g and 0.3 g cover the 31.8% of the territory and 7.6% of sites are between 0.3 and 0.4g.

The EC08 soil class map and the available database of Vs measurements were compared with the seismic soil map provided by the USGS based on a topographic slope-proxy (Allen and Wald, 2007). The latter is obtained by the correlation between topographic slope and $V_{S,30}$, assuming morphometrical characteristics of the terrain as representative of the lithology. The slope-based method appears less reliable than the proposed approach, because its predictions resulted in a slight but systematic overestimation of the measured soil classes. Therefore, the proposed map can be more suitable for large-scale seismic risk studies, despite it is not a substitute of seismic microzonation and local site response analyses.

Acknowledgments. This research was funded by the Italian Civil Protection Department RELUIS project 2010–2013, RS2 Task 2.1, 2.2 “Definition of geological models and site amplification for impulsive earthquakes near-source”.

Reference

Allen T.I., Wald D.J. (2007). Topographic slope as a proxy for seismic site-conditions (V_{S30}) and amplification around the globe. https://doi.org/10.3133/OFR20071357

EC08, Eurocode 08. (2003). CEN. European Committee for Standardization. Eurocode 8: design provisions for earthquake resistance of structures 2003.

Forte G., Chioccarelli E., De Falco M., Cito P., Santo A., Iervolino I. (2019). Seismic soil classification of Italy based on surface geology and shear-wave velocity measurements. Soil Dynamics and Earthquake Engineering 122 (2019) 79–93. https://doi.org/10.1016/j.soildyn.2019.04.002.

ItBC, Italian Building Code (2008). CS.LL.PP. Decreto Ministeriale: norme tecniche per le costruzioni, Gazzetta Ufficiale della Repubblica Italiana, n. 42, 20 febbraio, Suppl. Ordinario n. 8. Ist. Polig, e Zecca dello Stato S.p.a., Rome (2018), (in Italian).

RISPOSTA SISMICA LOCALE DEL THORNDON BASIN DI WELLINGTON (NUOVA ZELANDA)

S. Giallini[1], A. Pagliaroli[2], A. Pizzi[2], M. Moscatelli[1], A. Kaiser[3]

[1] Consiglio Nazionale delle Ricerche – Istituto di Geologia Ambientale e Geoingegneria (CNR-IGAG) Area della Ricerca di Roma 1 – Montelibretti, Italy

[2] Università G. d'Annunzio di Chieti-Pescara – Dipartimento di Ingegneria e Geologia (INGEO), Italy

[3] GNS Science, Te Pū Ao, Wellington, New Zealand

Introduzione. Il 14 novembre 2016 alle ore 12:00 (NZDT) un terremoto di M_w 7.8 (https://www.geonet.org.nz/earthquake/2016p858000), con epicentro nel distretto di Kaikoura, ha colpito l'Isola del Sud della Nuova Zelanda. L'evento ha causato uno scuotimento sismico estremamente elevato, con massime accelerazioni orizzontali (PGA) >1g fatte registrare in prossimità dell'epicentro (Bradley *et al*., 2017). Pur trovandosi a 250 km di distanza da questo, ingenti danni sono stati registrati a Wellington ed in particolare nella *Central Business District* (nel seguito anche CBD), il quartiere in cui lavora e risiede la maggior parte degli abitanti della capitale (Fig. 1). Al fine di comprendere se e quanto gli effetti di sito hanno contribuito all'elevato risentimento subito dalla città di Wellington, è stato condotto uno studio di risposta sismica locale focalizzato sull'area del CBD e in cui è stato riprodotto lo scuotimento sismico associato al terremoto di Kaikoura 2016.

Breve Inquadramento geologico dell'area di studio. La CBD di Wellington sorge all'interno del Thorndon Basin, uno dei principali bacini tettonici della regione. Il bedrock geologico e sismico locale è rappresentato dalle *Greywacke* della *Rakaia Terrane* (AA.VV), successioni di arenarie e peliti deposte da correnti di torbida di mare profondo, tra il Permiano e il Giurassico inferiore. In Fig. 1 si riporta la carta geologica (modificata da Kaiser *et al*., 2019) a cui si è fatto riferimento per questo studio. La ricostruzione di tre *cross-sections* che attraversano l'area di studio (ubicazione in Fig.1) ha messo in luce una morfologia sepolta tridimensionale del Thorndon Basin. Lungo la direzione NO-SE il Bacino risulta solo parzialmente confinato e presenta un bordo occidentale decisamente ripido (inclinazione ~80°), legato all'attività quaternaria della faglia di Wellington, che ne mette in contatto i sedimenti di riempimento pleistocenici, costituiti tipicamente da limo, sabbie e ghiaie (massima profondità raggiunta di