Soil Dynamics and Earthquake Engineering 31 (2011) 170–180

Contents lists available at ScienceDirect

Soil Dynamics and Earthquake Engineering

journal homepage: www.elsevier.com/locate/soildyn

# Istanbul Earthquake Rapid Response System: Methods and practices

Karin Sesetyan *, Can Zulfikar, Mine Demircioglu, Ufuk Hancilar, Yaver Kamer, Mustafa Erdik

*Bogazici University, Kandilli Observatory and Earthquake Research Institute, Department of Earthquake Engineering, 34684 Cengelkoy, Istanbul, Turkey*

ARTICLE INFO

*Article history:*
Received 11 September 2009
Received in revised form
18 February 2010
Accepted 28 February 2010

*Keywords:*
Earthquake rapid response
Istanbul
Shake-map
Loss-map

ABSTRACT

Potential impact of large earthquakes on urban societies can be reduced by timely and correct action after a disastrous earthquake. Modern technology permits measurements of strong ground shaking in near real-time for urban areas exposed to earthquake risk. The Istanbul Earthquake Rapid Response System equipped with 100 instruments and two data processing centers aims at the near real time estimation of earthquake damages using most recently developed methodologies and up-to-date structural and demographic inventories of Istanbul city. The methodology developed for near real time estimation of losses after a major earthquake consists of the following general steps: (1) rapid estimation of the ground motion distribution using the strong ground motion data gathered from the instruments; (2) improvement of the ground motion estimations as earthquake parameters become available and (3) estimation of building damage and casualties based on estimated ground motions and intensities. The present paper elaborates on the ground motion and damage estimation methodologies used by the Istanbul Earthquake Rapid Response System with a special emphasis on validation and verification of the different methods.



## 1. Introduction

Management of earthquake risks is a process involving pre-, co- and post-seismic phases. The pre-seismic phase involves all kinds of earthquake risk mitigation efforts from hazard assessment to the evaluation of seismic risk, and from development and enforcement of earthquake resistant design and retrofit codes to all measures taken to decrease vulnerabilities. The co-seismic phase includes the early warning systems and related measures such as public warnings and automatic shutdown processes. The rapid response systems take part immediately after the earthquake and provide a rapid estimation of ground shaking intensity (shake-maps) and/or physical damage and casualty (loss-maps). These maps can serve to assist civil protection authorities in the emergency action by directing search and rescue teams to the areas most needed.

After the 1999 Kocaeli and Duzce earthquakes, due to increased probability and recognized expectancy of a strong earthquake that could severely affect Istanbul, plans and preparations were made for the installation of an earthquake rapid response and early warning system for the city. In this connection, to assist in the reduction of losses in a damaging earthquake in Istanbul a dense strong motion network has been implemented. Altogether this network and its functions are called the Istanbul Earthquake Rapid Response System (IERRS, http://www.koeri.boun.edu.tr/depremmuh/EWRR/EWRRMain.htm). This system together with the Istanbul Earthquake Early Warning System is designed and operated by Bogazici University with the logistic support of the Governorate of Istanbul, First Army Headquarters and Istanbul Metropolitan Municipality [1,2]. The construction of the system is realized by the GeoSig and EWE (Switzerland) consortium. Communications are provided by AVEA GSM service provider.

Following a short presentation of the Istanbul Earthquake Rapid Response System (Section 2), the present paper elaborates on the methodologies used by IERRS for the computation of shake- and loss-maps with special emphasis on verification of results and validation of the different methods. The methodology of shake-map estimation originally developed for the IERRS is described in Section 3.1: Ground Motion Estimation without Earthquake Source Parameters. Currently we are revising and updating these methodologies in light of the new developments achieved under the EU FP6 NERIES Project (http://www.neries-eu.org/). These developments will be encompassed under the heading "Ground Motion Estimation with Earthquake Source Parameters" (Section 3.2). Section 3.3 is dedicated to a critical evaluation of these methods. Macroseismic intensity predictions are covered in Section 3.4. Loss estimations based on shake-maps and building and population inventories are elaborated in Section 4.

## 2. The Istanbul Earthquake Rapid Response System (IERRS)

Following the 1999 Kocaeli earthquake, the high probability of a large event affecting Istanbul in the near future has been put forward

* Corresponding author. Tel.: +90 216 516 33 69; fax: +90 216 308 01 63.
*E-mail addresses:* karin@boun.edu.tr, ksesetyan@gmail.com (K. Sesetyan).

0267-7261/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.soildyn.2010.02.012