Engineering Failure Analysis 18 (2011) 868–889

Contents lists available at ScienceDirect

Engineering Failure Analysis

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

Failures of masonry and concrete buildings during the March 8, 2010 Kovancılar and Palu (Elazığ) Earthquakes in Turkey

Zekai Celep [a], Ayfer Erken [b], Beyza Taskin [a], Alper Ilki [c,*]

[a] Istanbul Technical University, Civil Engineering Faculty, Structural Engineering Department, 34469 Istanbul, Turkey
[b] Istanbul Technical University, Civil Engineering Faculty, Geotechnical Engineering Department, 34469 Istanbul, Turkey
[c] Istanbul Technical University, Civil Engineering Faculty, Structural and Earthquake Engineering Laboratory, 34469 Istanbul, Turkey

ARTICLE INFO

Article history:
Received 16 May 2010
Received in revised form 31 October 2010
Accepted 4 November 2010
Available online 3 December 2010

Keywords:
Earthquake damage survey
Kovancılar (Elazığ) earthquake
Masonry buildings
Reinforced concrete buildings
Strong ground motions

ABSTRACT

The March 8, 2010 earthquakes that hit Kovancılar and Palu districts of Elazığ province in Turkey and their impacts on masonry and concrete buildings are studied in this paper. According to United States Geological Survey (USGS), magnitudes of these earthquakes, which caused partial or total collapse in many buildings with life losses, were 6.1 and 5.5, respectively. This paper outlines the seismological aspects of the region, the characteristics of the strong ground motion, the geotechnical characteristics of the region and the structural damages based on site assessments. The structural damage level is observed to be directly proportional with the amount of the insufficient quality in the workmanship and usage of inadequate building materials. If a minimum amount of engineering attention had been paid during the construction stages, most of the existing buildings could have sustained the earthquakes without considerable damage.

1. Introduction

On March 8, 2010, an earthquake of moderate intensity shook Kovancılar district and the surrounding villages of Elazığ province at 04:32 (02:32 GMT) local time. Being one of the most seismically active zones in Turkey, Elazığ settles on the East Anatolian Fault (EAF), almost at the north-eastern end, where EAF meets the well known North Anatolian Fault (NAF) at the Karlıova triple junction. Magnitude and source characteristics of the earthquake are defined by various institutions as given in Table 1. In the table, h_{hypo} is the depth of hypocenter of the earthquake and M is the local magnitude (M_L) for the top two rows and the moment magnitude (M_w) for the other rows.

The earthquake struck a region of about 10,000 population and caused 42 human casualties and injuries of 137 individuals. According to the Governorship of Elazığ [1], approximately 3000 residential and 181 office buildings were heavily damaged. Stockbreeding sector is seriously affected with a loss of more than 3000 farm animals due to the collapse of barns. Most of the damages were observed in Okçular, Yukarı Demirci, Kayalık and Göçmezler villages within the political boundaries of Kovancılar district. Although Kovancılar and Palu city centers were the two closest districts to the epicenter, most buildings withstood against the shock without experiencing damages. Followed by the main event, however, an aftershock of $M_L = 5.6$ at 07:47GMT caused damages in Palu district (Table 2).

Few days after the earthquakes, our reconnaissance team arrived at the region (Fig. 1) to carry out site investigation and damage assessment. Kovancılar and Palu districts and the villages Kayalık, Yukarı Demirci, Okçular, Göçmezler, Taban Özü, Çakırkaş, Köklüce, Gökdere, Arındık and Beyhan, are taken into the scope of this survey.

* Corresponding author. Tel.: +90 212 285 3838; fax: +90 212 285 6587.
E-mail addresses: celep@itu.edu.tr (Z. Celep), erken@itu.edu.tr (A. Erken), btaskin@itu.edu.tr (B. Taskin), ailki@itu.edu.tr (A. Ilki).

1350-6307/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engfailanal.2010.11.001