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CHARACTERIZATION OF SEISMIC DEMAND AFTER THE CENTRAL ITALY 2016 EARTHQUAKES

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Abstract

A complex sequence of seismic events occurred in central Italy from the end of August to the end of October 2016. The significant magnitudes of the main seismic events resulted in considerable damage in different cities and villages (Fig. 1), as well as architectural heritage.

The long seismic sequence that affected a large area of central Italy covering four regions and lasting about three months, was characterized by four significantly strong quakes with magnitude greater than or equal to 5.4 caused by normal faulting, which is the prevalent faulting style in the area.

The first strong earthquake of the sequence (M_W 6.0) struck central Italy on 2016-08-24 at 01:36:32 GMT, close to Amatrice, causing diffuse building collapse and about 300 casualties. On 2016-10-26 other two events of moment magnitude 5.4 (17:10:36 UTC) and 5.9 (19:18:06 UTC) affected an area extended to the NW of the August event. After four days, on 2016-10-30 at 06:40:18 UTC an event of M_W 6.5 was recorded, with epicenter located close to Norcia.

(a) (b)

Fig. 1. Damage to masonry (a) and reinforced concrete buildings (b)

Numerous accelerometer stations (about 650) belonging to the Italian Strong Motion Network (RAN, Rete Accelerometrica Nazionale, managed by the Department of Civil Protection) and to the Italian seismic network (RSN, Rete Sismologica Nazionale), managed by the Istituto Nazionale di Geofisica e Vulcanologia, were triggered by the mainshocks.

The largest Peak Ground Acceleration among the four events have been recorded at short epicentral distances at the stations Campi (CMI, 0.721 g, E-W component), Castel Santangelo sul Nera (CNE, 0.557 g, E-W component), Accumoli (ACC, 0.434 g, E-W component), Amatrice (AMT, 0.530 g, E-W component), Norcia (NRC, 0.485 g, E-W component). The Peak Ground Velocities (PGV) and the Incremental Velocities (IV) recorded during these events, reached values higher than 50 and 70 cm/s, respectively.

On the one hand, in this earthquake, as well as in other earthquakes occurred in Italy, structural damage was essentially due to structural deficiencies caused by design or construction process and/or age, lack of ductility, inadequate materials, inappropriate detailing. In several locations it was found that mortar was made of mud and apparently lacking any lime. On the other hand, the ground shakings exceeded in some cases the design levels (Fig. 2). Moreover, possible pulse effects due to directivity could have increased the demand to structures beyond the design level.

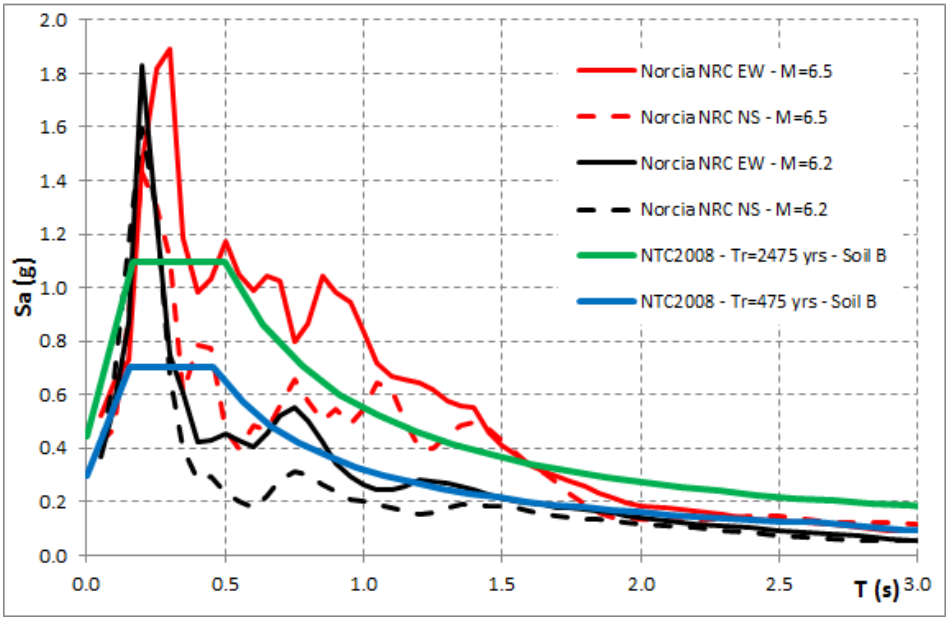

Fig. 2. Comparison between recorded ground motion (Norcia station) spectra and code elastic spectra

The purpose of this study is to review the general characteristics of the building stock in the region and to correlate the observed structural damage with the recorded main-shock strong ground motion data. Moreover, as many historical town centers were affected by the seismic shaking, suffering extensive damage and losses of their architectural heritage, a study on damage to historic buildings is carried out.

Keywords: central Italy earthquakes, strong motion recorded data, observed damage, modern buildings, historic buildings